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1 OF 2
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1.0
1.1
1.25
1.4
1.6
2.8
3.2
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4.0
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1.8
MICROCOPY RESOLUTION TEST CHART

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Texas A&M University
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This report evaluates the technical performance of 32 long-term drifters deployed in the Anomaly Dynamics Study special observing periods I and II. A description is given of the Random Access Measurement System on Nimbus 6, the design characteristics of the drifters, and the drogue indicator. We consider the overall technical performance of the system to be excellent. The satellite system has proved to be a highly reliable means of locating platforms and telemetering data from remote regions of the ocean.

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TECHNICAL EVALUATION OF

ADS I AND II DRIFTER PERFORMANCE

ONR CONTRACTS N00014-75-C-0537
N00015-75-C-1052

TAMU Reference 78-3-T

by

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Abstract

This report evaluates the technical performance of 32 long-term drifters deployed in the Anomaly Dynamics Study special observing periods I and II. A description is given of the Random Access Measurement System on Nimbus 6, the design characteristics of the drifters, and the drogue indicator. We consider the overall technical performance of the system to be excellent. The satellite system has proved to be a highly reliable means of locating platforms and telemetering data from remote regions of the ocean.

Table of Contents

I. Introduction

The Anomaly Dynamics Study (ADS) was started in 1975 as a five-year program whose long-range goal is:

> "Describe and understand the mechanisms responsible for large scale climatological anomalies and related changes in the thermal structure and the general circulation of the upper layers of the ocean in order to predict their formation and evolution."

One of the steps necessary, to achieve this goal was to devise a technique for monitoring the large scale near surface flow over a vast region in the central North Pacific. To this end, a significant effort was expended in perfecting a technique for inferring the currents from satellite tracking of drogued drifters.

During the second and third years of ADS there were three special observing periods. In these periods particular attention was focused on the area bounded by 170° W to 150° W and 35° N to 45° N. From June-July 1976, September 1976 and May-June 1977 extensive observations were taken in this area. These included XBT surveys from ships of opportunity, closely spaced hydrographic stations, AXBT surveys from Navy P-3's and the deployment of 16 drifters each in ADS I and II and 19 in ADS III.

To our knowledge the largest deployment of drifters focused on a single scientific goal was made in ADS I, II, and III. Because of the large number of drifters deployed and because of the novelty of the approach, it is important to document the technical performance

of this system. This is the purpose of this report. However, only the results from ADS I and ADS II are presented. The data from the ADS III deployment is still coming in and so a report on that experiment will be made at a later date.

II. Nimbus 6

Central to the success of this program is the Nimbus 6 spacecraft. This is a sun-synchronous polar orbiting satellite with an orbit altitude of about 1100 km. It crosses the equator northbound at local noon and southbound at midnight. The orbit has a 81^{o} retrograde inclination and successive orbits precess to the west by 26.8^{o} longitude. The orbital period is about 109 minutes.

Among the experiments conducted by this spacecraft is the Tropical Wind Energy Conversion and Reference Level Experiment (TWERLE). This experiment utilized two capabilities of the Random Access Measurement System (RAMS) in dual mode. They are data transmission and relay, and platform location capabilities. The ADS utilized the same capabilities for oceanography.

Briefly, the RAMS operates in the following manner (Sissala, 1975). A one second duration signal is transmitted from each drifter every 64 seconds of its life regardless of whether or not the satellite is in a position to receive it, hence the name "random access." The one second signal is comprised of a crystal controlled tone, four eight bit data words and a ten bit identification number unique to each buoy. The drifter's positions are computed by the RAMS from the Doppler shift observed in the crystal controlled tone transmitted by the drifter and the speed and location of the satellite during flyover. The system provides position with an accuracy of ± 5 km from the data collected

from two consecutive orbits. Data from a single orbit yields an ambiguous result, two positions, one on either side of the satellite's orbital subtrack, which can be resolved in most cases by using previous position data. Due to the satellite's orbit, the number of positions provided by the system is a function of latitude varying from a minimum of two per day at the Equator to a maximum of about 13 per day at the poles.

We have found the data transmission capability of RAMS to be exceptionally well suited for many oceanographic studies. For example, at mid-latitudes, the satellite may "see" a platform six or seven times during a 24 hour period. In some cases, only one or two messages will be received by the satellite. Although this is not sufficient for position fixing, the data words are almost always good. For example, we have been able to observe the diurnal cycle in the sea surface temperature (Kirwan et al., 1978).

III. Launch Schedule

Table 1 summarizes the Julian day, Greenwich time and location of the ADS I deployment. Table 2 does the same for ADS II. Figure 1 presents a composite plot of the percent of drifters remaining as a function of time from the launch for both ADS I and II. This figure shows the mean time to failure, i.e., when half the drifters are still active, to be 180 days for ADS I and 325 days for ADS II. The reason for this difference is that it was possible to perform more bench tests on the buoy transmit terminals (BTT) designated for the second deployment.

IV. Description of Drifter System

In order to utilize the RAMS in an investigation of near surface

TABLE 1

ADS I Summary

ID	Launch Site Lat.	Long.	Time of Launch		Last Position Lat.	Long.	Time of Last Report	
0115	37.00	162.00	184	02:50	34.90	159.18	323	21:06
0123	39.00	154.00	190	11:04	33.87	137.26	*207	19:28
0152	41.00	154.00	190	13:33	35.24	133.48	*220	19:16
0164	43.00	162.00	185	16:55	43.10	159.02	221	22:51
0213	39.00	162.00	184	14:42	38.23	139.57	*105	21:15
0225	37.00	158.00	187	23:34	34.36	136.58	*121	18:54
0254	41.00	158.00	187	11:05	36.30	130.27	*224	09:49
0262	43.00	154.00	191	12:04	43.12	153.90	194	23:57
0407	43.00	158.00	186	09:30	47.89	139.02	*020	07:51
0431	41.00	166.00	179	18:35	41.05	155.41	304	21:55
0440	41.00	162.00	185	03:25	41.23	129.42	*205	19:03
0476	37.00	166.00	181	13:00	35.55	136.71	*172	20:44
0701	37.00	154.00	189	21:54	38.75	138.63	*108	19:08
0737	43.00	166.00	179	01:55	40.47	159.75	233	13:05
0746	38.00	166.00	181	07:00	38.18	170.62	246	21:26
0770	39.00	158.00	187	11:05	38.59	155.08	270	22:28

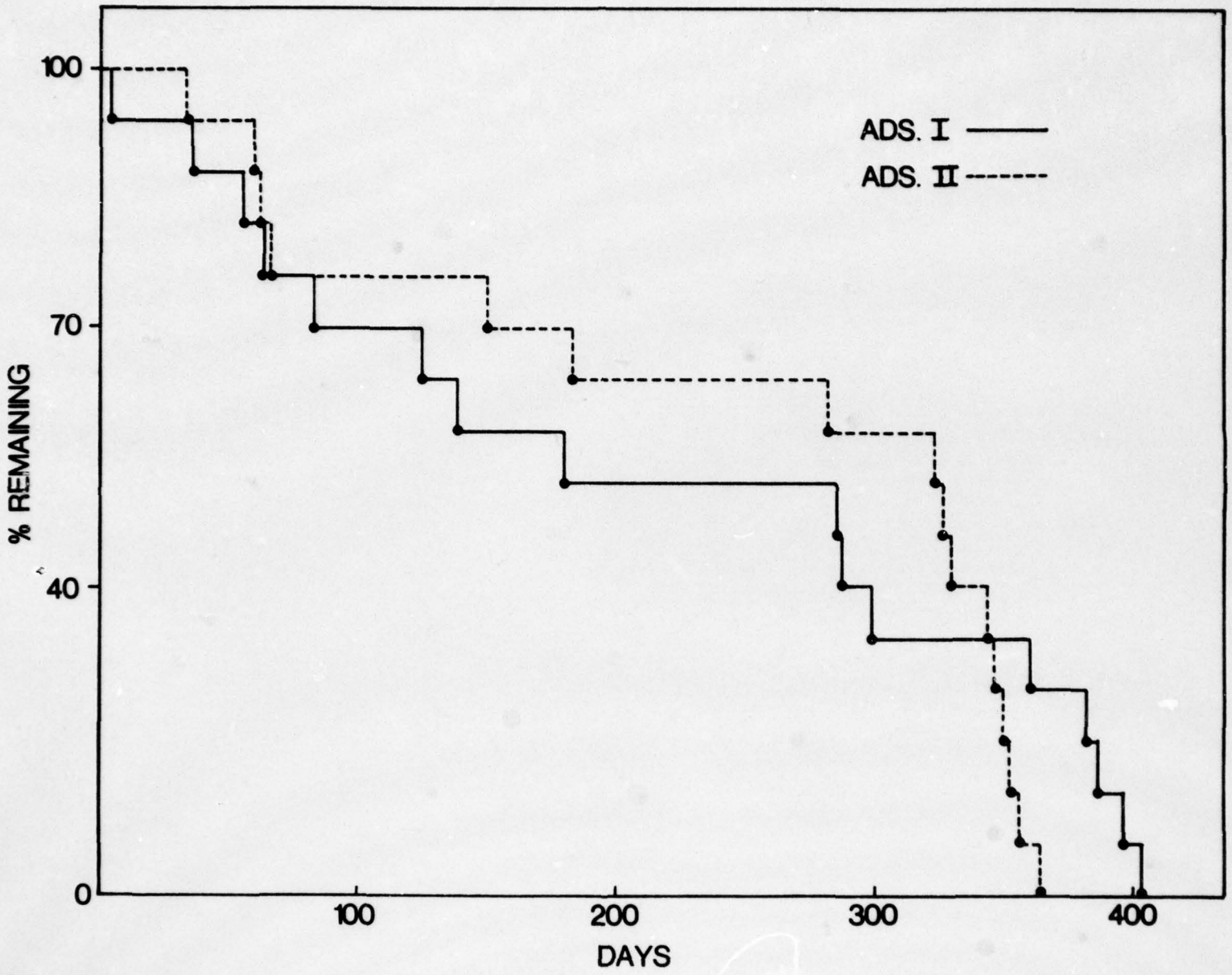
*1977

TABLE 2

ADS II Summary

ID	Launch Site Lat.	Long.	Time of Launch		Last Position Lat.	Long.	Time of Last Report	
1001	39.00	162.00	261	10:42	38.41	158.35	323	21:08
1037	39:00	166.00	258	11:05	35.78	132.43	*247	20:03
1046	45.00	154.00	270	12:22	57.85	138.27	*087	10:55
1070	43.00	166.00	257	07:00	48.22	147.92	*047	19:01
1307	41.00	166.00	257	21:21	42.82	134.48	*235	09:16
1331	41.00	154.00	269	09:51	34.63	127.74	*224	09:48
1340	39.00	158.00	265	17:55	38.52	157.74	316	20:41
1376	45.00	162.00	263	09:57	59.81	147.65	*250	07:37
1513	43.00	158.00	264	12:27	50.38	130.75	*245	17:58
1525	43.00	154.00	269	23:33	39.58	127.69	*254	20:32
1554	39.00	154.00	268	20:01	39.64	153.46	303	20:51
1562	43.00	162.00	262	15:41	56.79	135.48	*222	09:22
1615	45.00	166.00	256	19:10	59.91	141.34	*174	20:52
1623	45.00	158.00	263	23:02	45.00	149.41	323	21:09
1652	41.00	162.00	262	00:35	35.21	138.15	*222	19:42
1664	41.00	158.00	265	03:12	33.39	132.65	*262	18:28

*1977



Percent of drifters remaining as a function of time for ADS I and II

Figure 1

ocean circulation, a drifting buoy system or drifter was developed. The drifter system mechanical design was driven by four criteria:

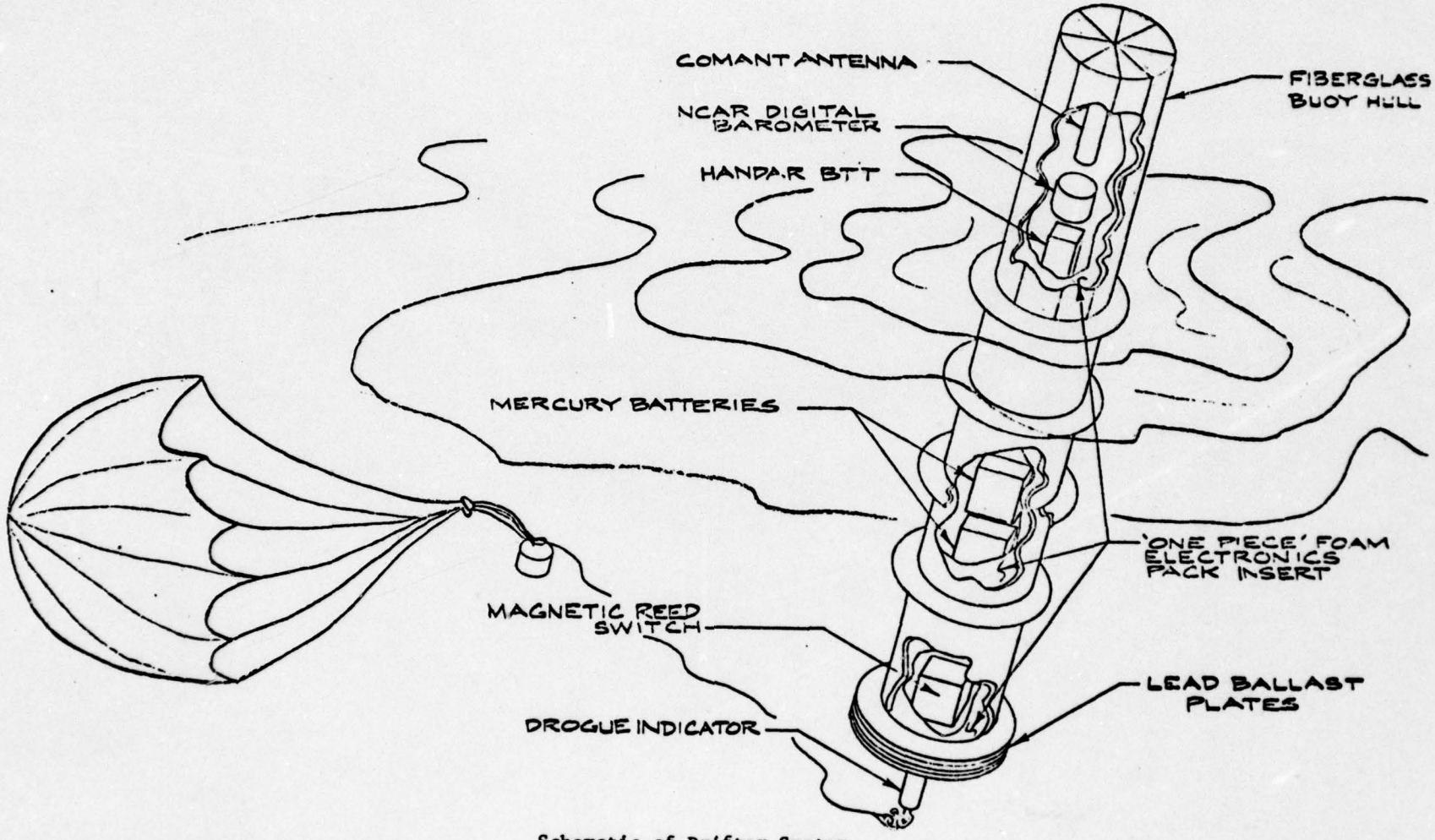
1. It must have a surface element in order to communicate with the RAMS.
2. The drag area exposed to the wind necessitated by 1 must be made as small as possible compared to the drag area which coupled the system to the near surface ocean current.
3. The system must have a minimum life expectancy of six months since the remoteness of the deployment area coupled with the high cost of ship time precluded any systematic recovery program.
4. The system must be rugged enough to survive not only the rigors of the harsh environment of the mid-latitude North Pacific winter but also those encountered in transporation and deployment.

The mechanical configuration resulting from the design criteria is shown in figure 2.

The damped spar hull is a single piece of molded fiberglass with a wall thickness of 1.27 cm. The hull is 3.05 meters long and has a diameter of 38.1 cm. The water line is 1 meter from the top after ballasting via 113.5 kg of lead bolted to the bottom. Four 68.58 cm diameter damping rings drilled with 5.08 cm diameter randomly placed holes spaced 45.72 cm apart glassed into the submerged portion of the hull reduce the hull natural heave response.

The fact that the hull is fiberglass and has a 35.56 cm inside diameter allowed us to place the transmitter's antenna inside the

NORPAX DRIFTER SYSTEM



Schematic of Drifter System

Figure 2

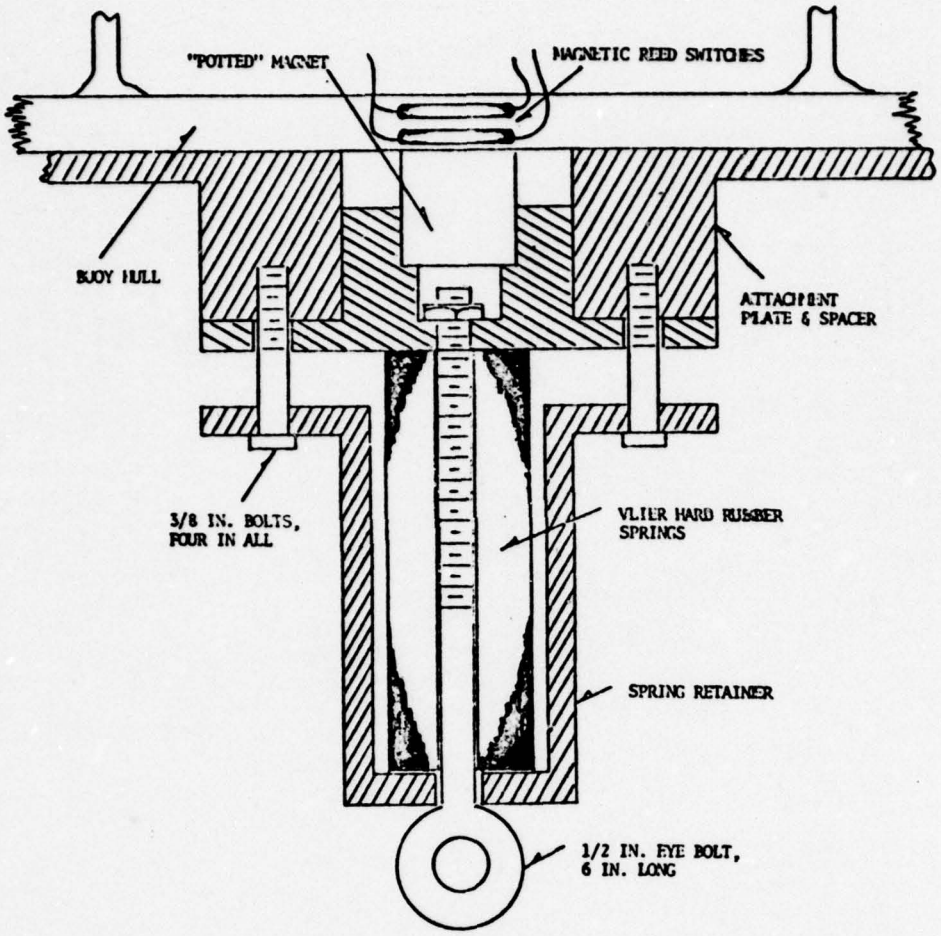
hull. We felt this made a significant contribution to the system lifetime in that it moved the weakest structural member from the area of strongest environmental stress, the top of the hull, to a region of essentially no environmental stress.

The dry surface area of 0.37 m exposed to wind drag is fixed by the antenna length and hull diameter. A surplus personal parachute 8.5 meters in diameter with approximately 55.74 m of drag area when fully open was chosen as the drogue element in an effort to minimize the effect of the wind on the drifter motion.

It was felt that the drogue system's life expectency would not match that of the rest of the system. The loss of the drogue would drastically change the ratio of the wet on a dry drag area and thus we would expect a sudden change in system performance. A sensor was developed to monitor the integrity of the drogue system.

The "drogue indicator" developed for this purpose is shown in figure 3. The reed switches which are glassed into the bottom of the hull are normally open. The switch furthest from the magnet will remain closed until the magnet is pulled 0.64 cm away from its unstressed position. A deflection of 0.64 cm results from a load 1.81 to 2.72 kg above the load of the 22.68 kg drogue ballast alone. The switch closest to the magnet will not open until the magnet has moved through its maximum allowable travel, 1.27 cm, corresponding to load in excess of 45.36 kg.

The normal operating mode for the indicator is for the switch furthest from the magnet to be open almost all the time while the second switch remains closed. Under heavy sea conditions the second



Drogue Indicator Assembly

Figure 3

switch will close occasionally due to the large shock loads incurred by wave pumping. This operation was observed during our recent deployment.

Three types of drogue failures are expected:

1. Drogue system plus indicating mechanism is lost: both switches will remain open all the time.
2. Drogue line and ballast remain but the parachute is lost: switch furthest from magnet will open occasionally due to wave action, but second switch would rarely, if ever, open.
3. Drogue line parts: both switches remain closed.

One other sensor was added to the drifter, sea surface temperature. This is measured by means of a Yellow Springs Instrument - - - thermo-linear thermistor. The thermistor is located on the side of the hull at the very bottom some 2.13 meters below the surface.

The buoy's payload consisting of a satellite transmitter, antenna, and battery power supply are encased in a urethene foam cylinder. The foam package is made of two matching parts symmetrical about the length of the cylinder. The matching halves are molded to accept the payload component parts. When assembled the foam package slips inside the hull. Running down the inside of the hull is a 2.54 cm half round spine. The foam package has a matching notch along its length which serves to locate the foam package inside the hull and prevent it from rotating inside the hull.

The transmitter used in ADS I and II is the Handar Model 420D BTT. Its characteristics are:

Transmitter Frequency	401.2 Mhz ±6 Khz
Short term stability	< 1 x 10
Long term stability	< 7.5 x 10
Signal Format	
Carrier on time	340 ms ± 3.4 ms
ID & date	64 bits
Bit time	10 ms ± 0.1 ms
Cycle time	64 sec ± 0.64 sec
Data Words	
4 analog data words	
1 battery volt	
2 sea surface temperature	
3 drogue indicator switch 1	
4 drogue indicator switch 2	
Power Requirements	
Supply voltage	12 volts + 0.5v - 1.5v
Current	500 ma during transmission
	8 ma quiescent
	15 ma average
Mechanical	
Dimensions	12.7 x 10.16 x 30.48 cm
Weight	1.81 Kg

The antenna is a vertical dipole manufactured by Comant Industries.

The battery power supply consists of parallel stacks of Mallory RM.2550R mercury batteries. Each stack is diode isolated from the 12.35 volt line so that failure of one stack does not cause total failure. The total capacity of the batteries is 117 ampere hours. Allowing for 10% - - - due to adverse environmental operating temperature and pre-deployment testing, this battery pack should provide for a nominal system life expectancy of 270 days.

V. Conclusions

As indicated in section III, the use of the Nimbus 6 for data transmission and relay has been an unqualified success. The limiting factor in drifter lifetime is battery life. The data transmitted through this system has been of exceptionally good quality and the position functioning capabilities of RAMS is better than originally designed.

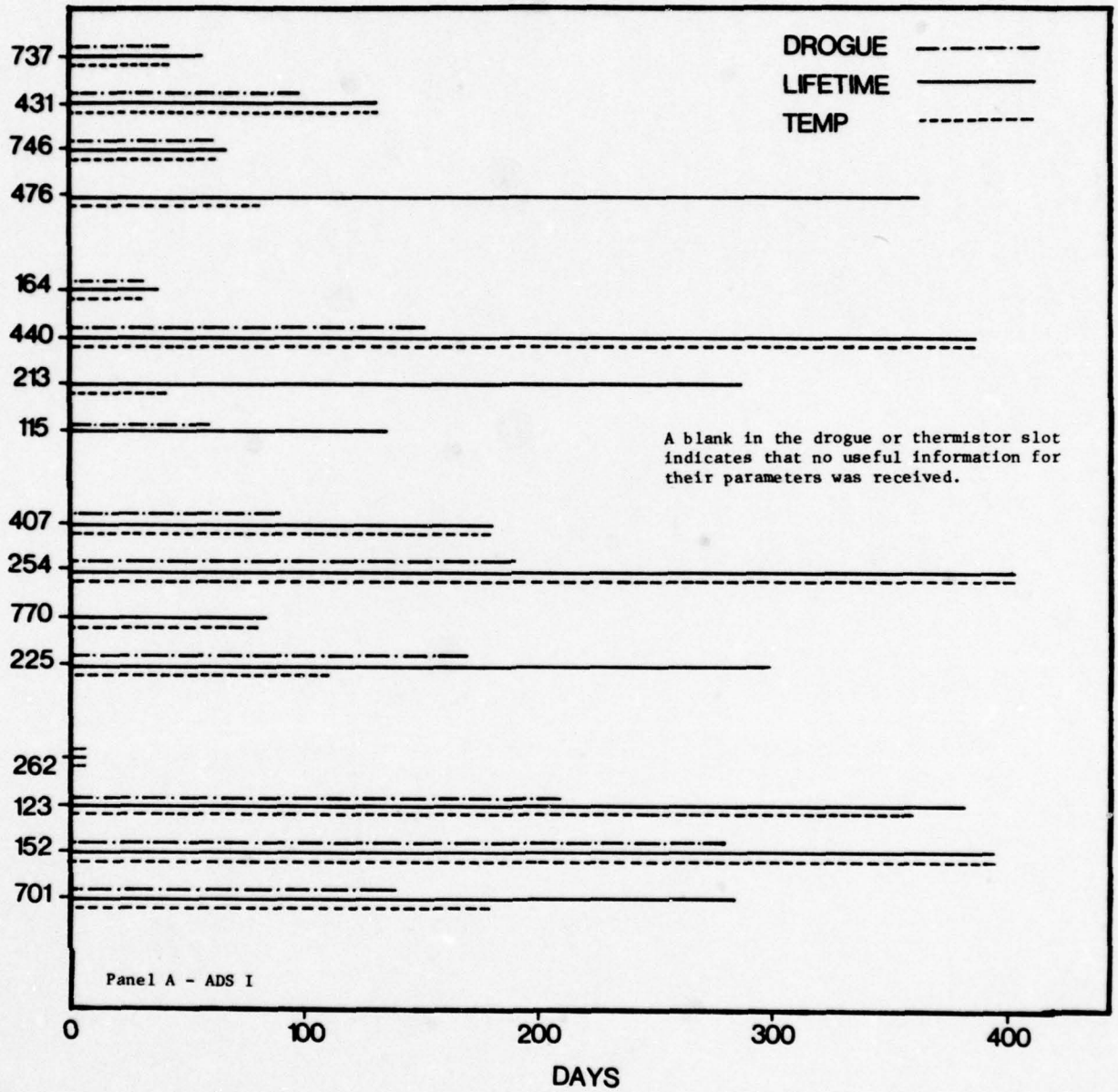
All the failures have been at the wet end of the system. These failures are of two types. The non-fatal type is the loss of data words from specific sensors. This does not interfere with the primary mission of the drifter which is to provide position data. In most cases in ADS I and II this failure has been traced to a failure of the buoy transmitter or connectors. In later deployments the quality of the connectors has been upgraded, resulting in a dramatic improvement of the data words.

Fatalities occur when the drifter ceases to transmit. This can happen one of two ways. Normally it is the result of battery fatigue. In this case it is common to see a sharp decline in the batter voltage just before the drifter goes off the air. The other fatal mode is catastrophic. This occurs when the drifter ceases to transmit well before the end of its nominal lifetime. Based on experiments from laboratory tests, this likely is caused by a malfunction in the transmitter.

As indicated in section IV the design of the buoy was such that failure of the data words would not jeopardize the primary mission

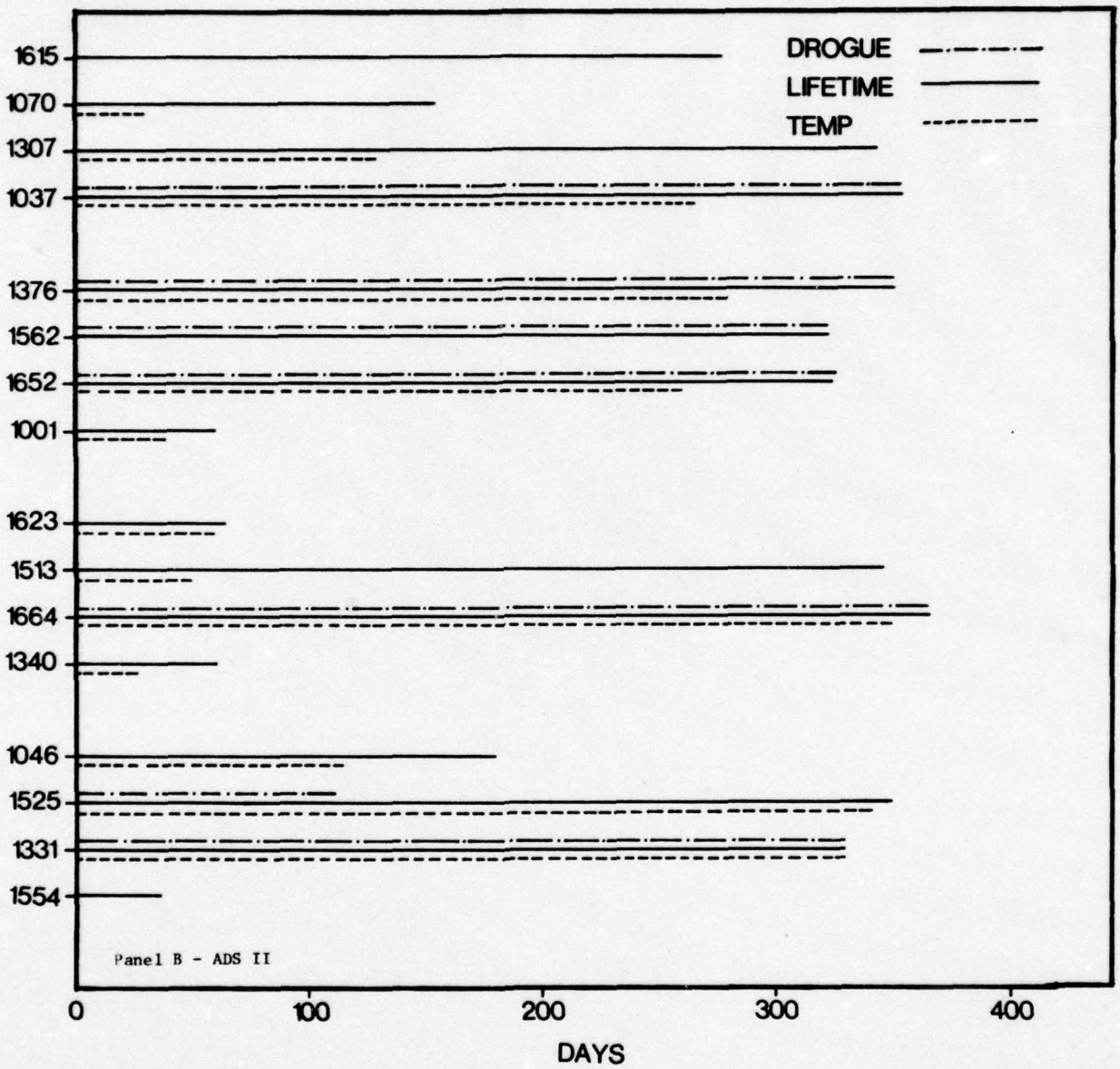
of the drifter, namely to provide position information. As seen in figure 4, this does not occur. It is clear from this figure there is no correlation between failures of the drogue indicator with failures of the sea surface temperature sensor.

The appendix gives the complete trajectories for each of the drifters along with the complete record of each of the data words.



Summary of Drifter, Drogue and Thermistor Lifetimes

Figure 4



Summary of Drifter, Drogue and Thermistor Lifetimes

Figure 4

Acknowledgements

We wish to thank the crews of the R. V. Kana Keoki for their assistance in the ADS I deployment and the R. V. Wecoma for the ADS II deployment. The Office of Naval Research provided financial support for this experiment under contracts N0014-75-C-0537 at Texas A&M University and N0015-75-C-0152 at the Scripps Institution of Oceanography.

References

1. Sissala, John E. The Nimbus 6 User's Guide. The LANDSAT/Nimbus Project Goddard Space Flight Center, National Aeronautics and Space Admin. February, 1975, 227 pp.

2. Kirwan, A. D., Jr., N. L. Guinasso, Jr., and G. McNally, 1978: Sea surface temperature in the North Pacific through the winter 1976-1977 from Nimbus 6. (submitted for publication)

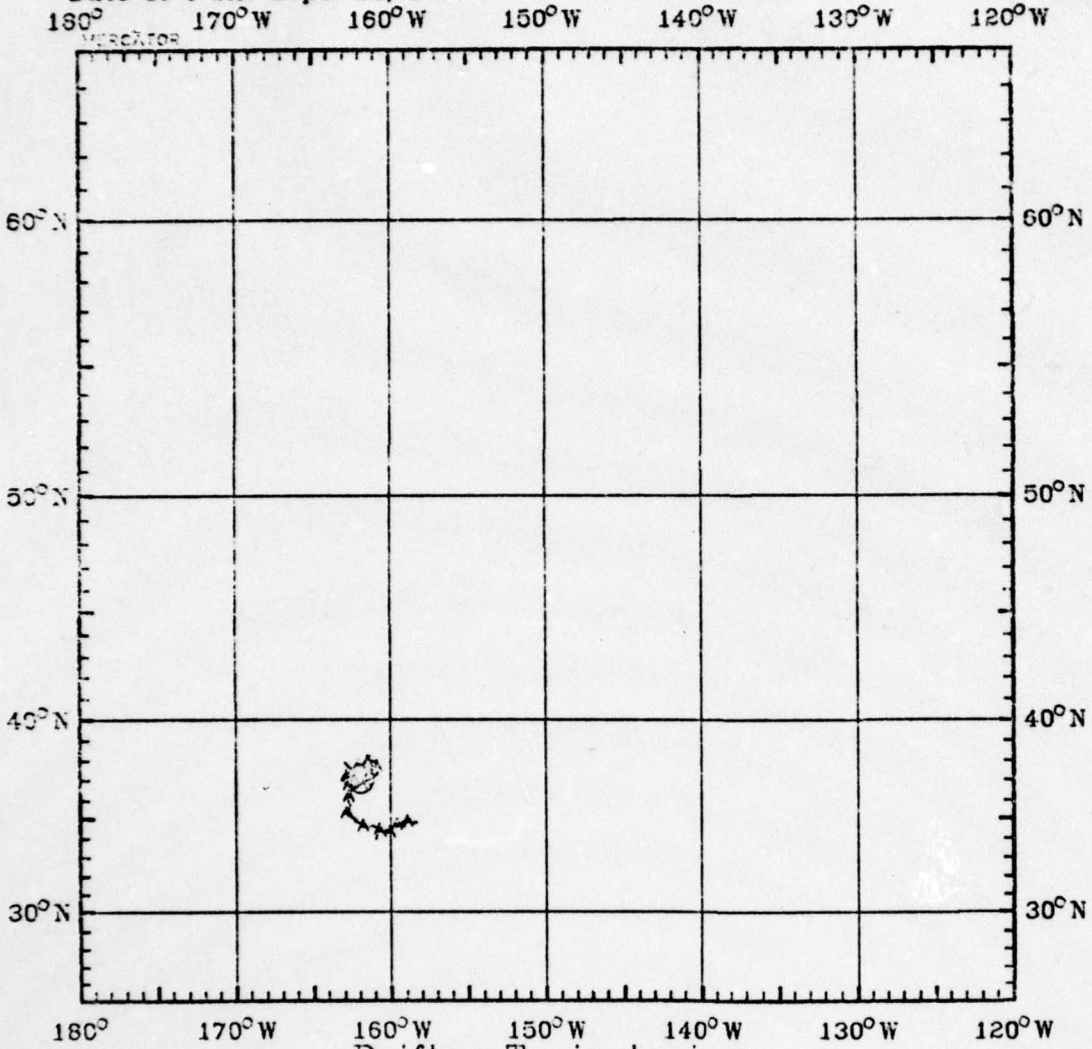
Appendix

Complete Trajectories and Data Words from ADS I and II.

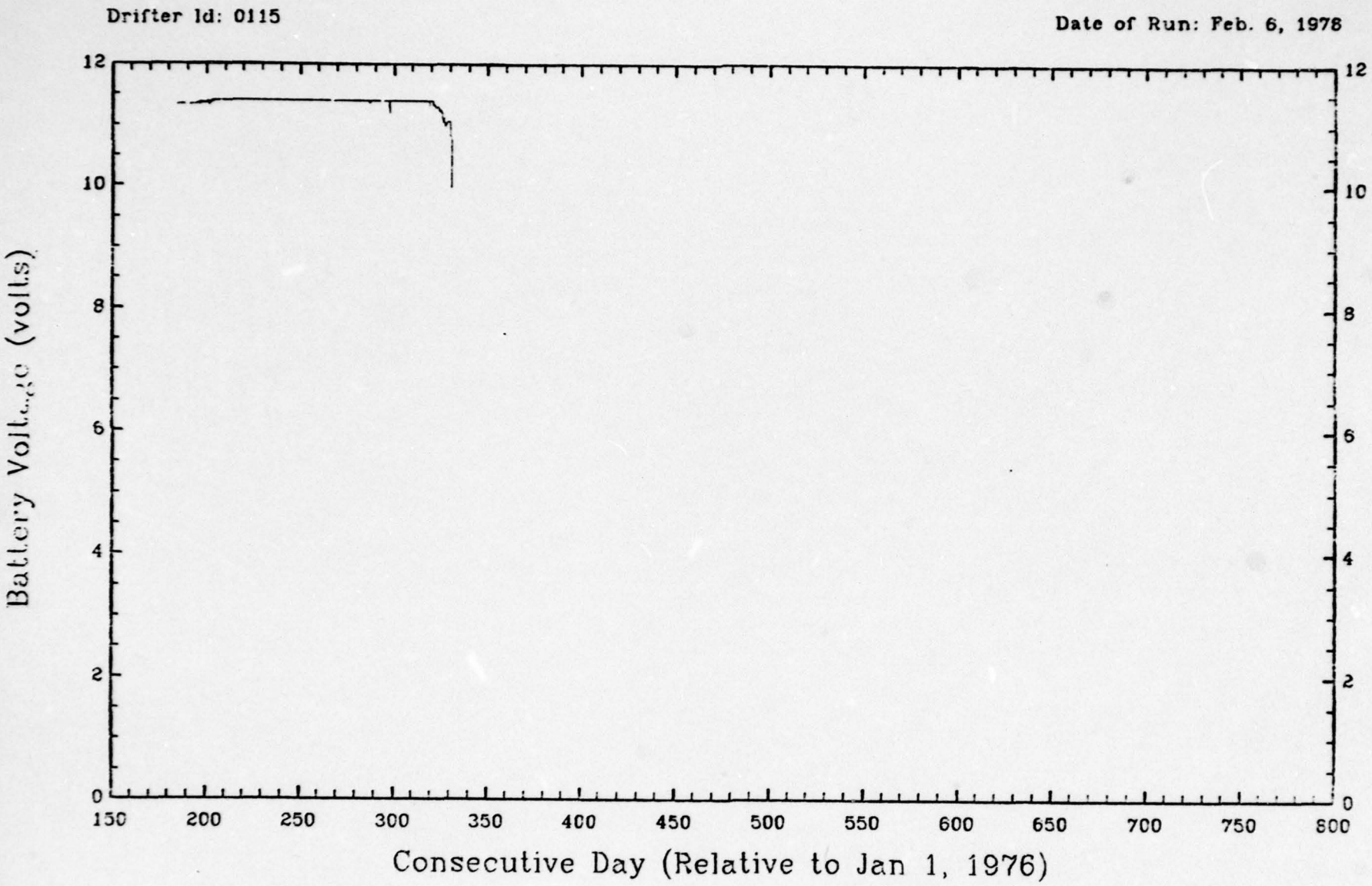
Date of Run: Sept. 15, 1977

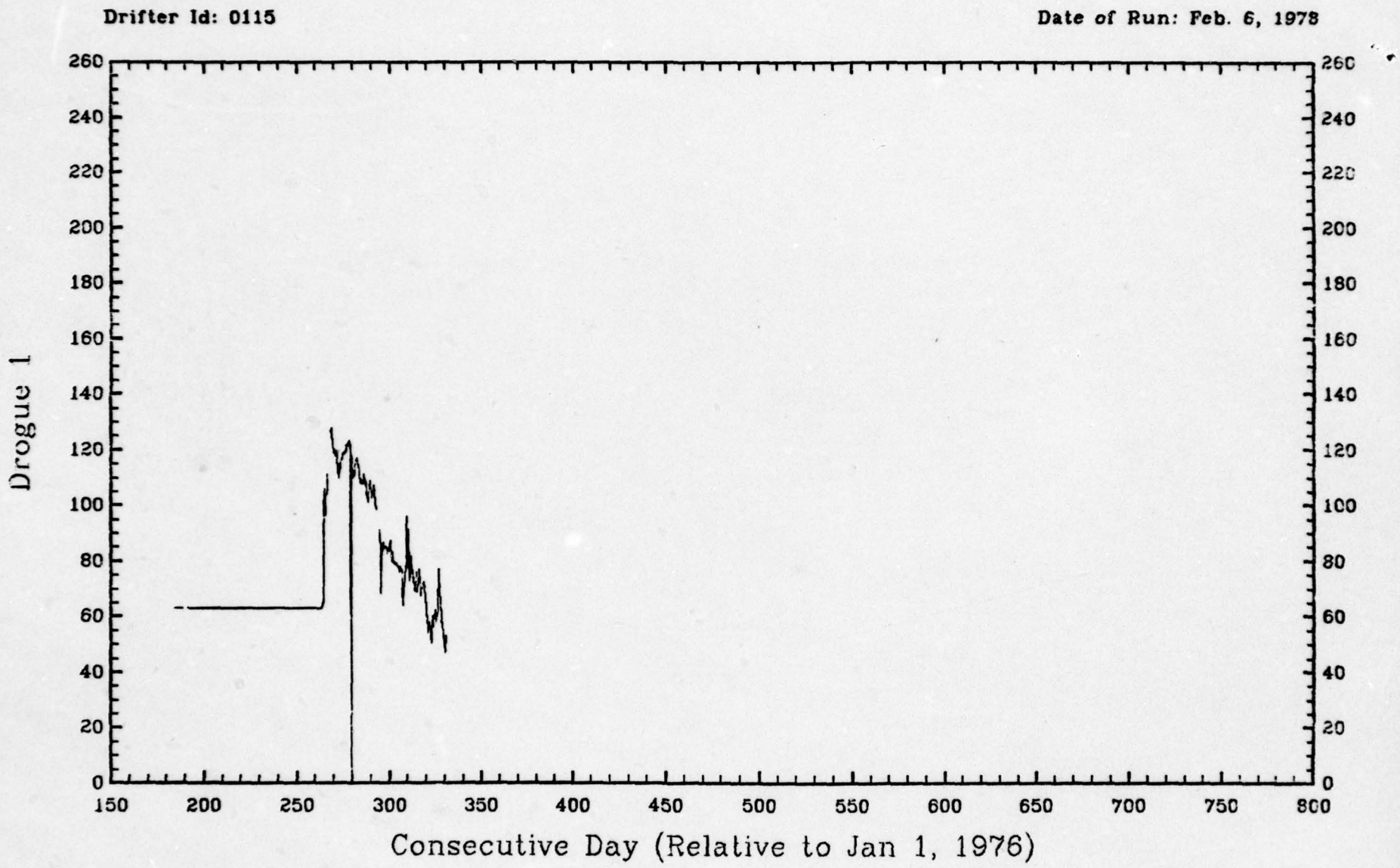
Period Covered:
June 1, 1976 to Sept. 15, 1977

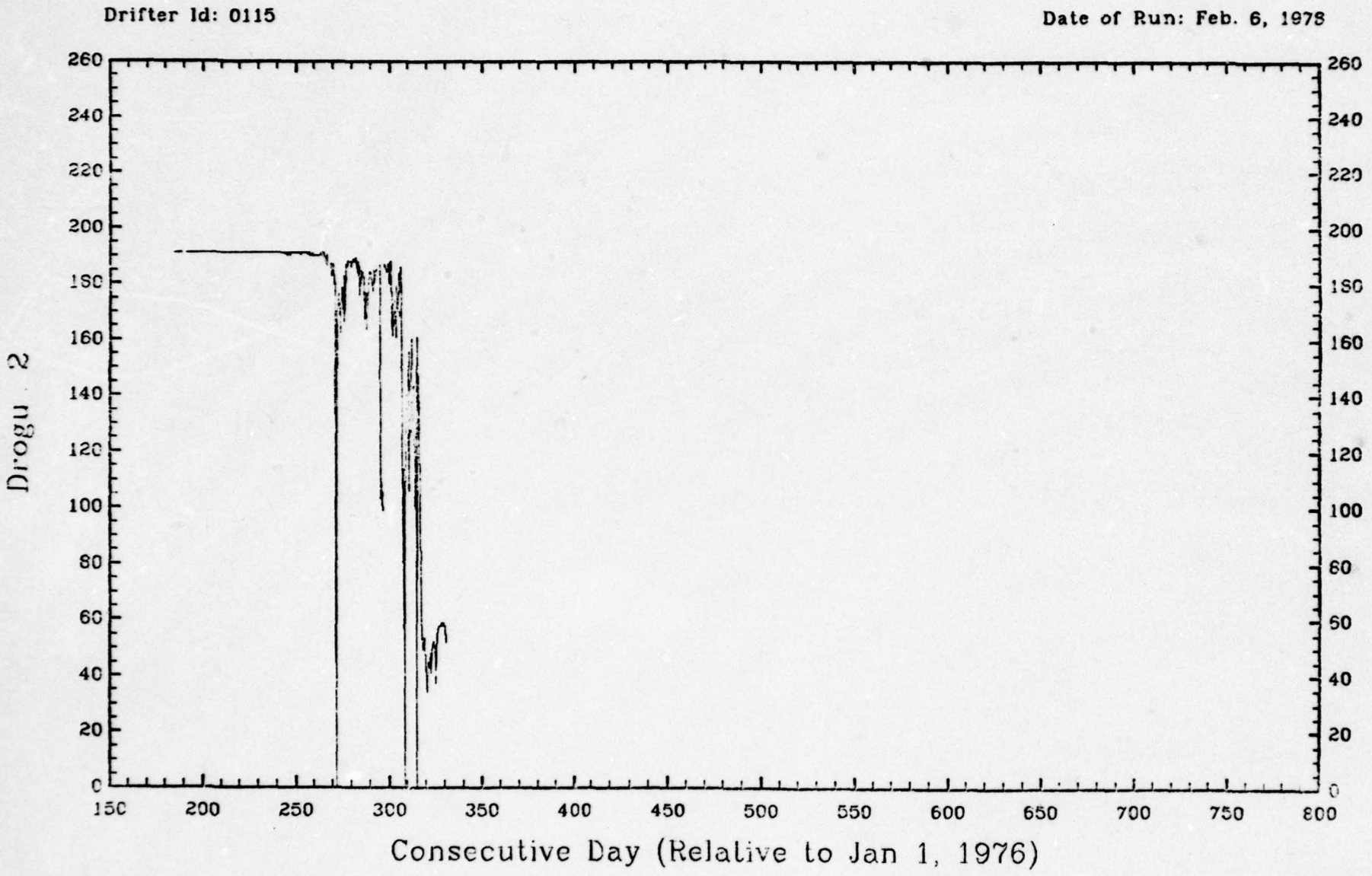
Symbol	Drifter Id
A	0115

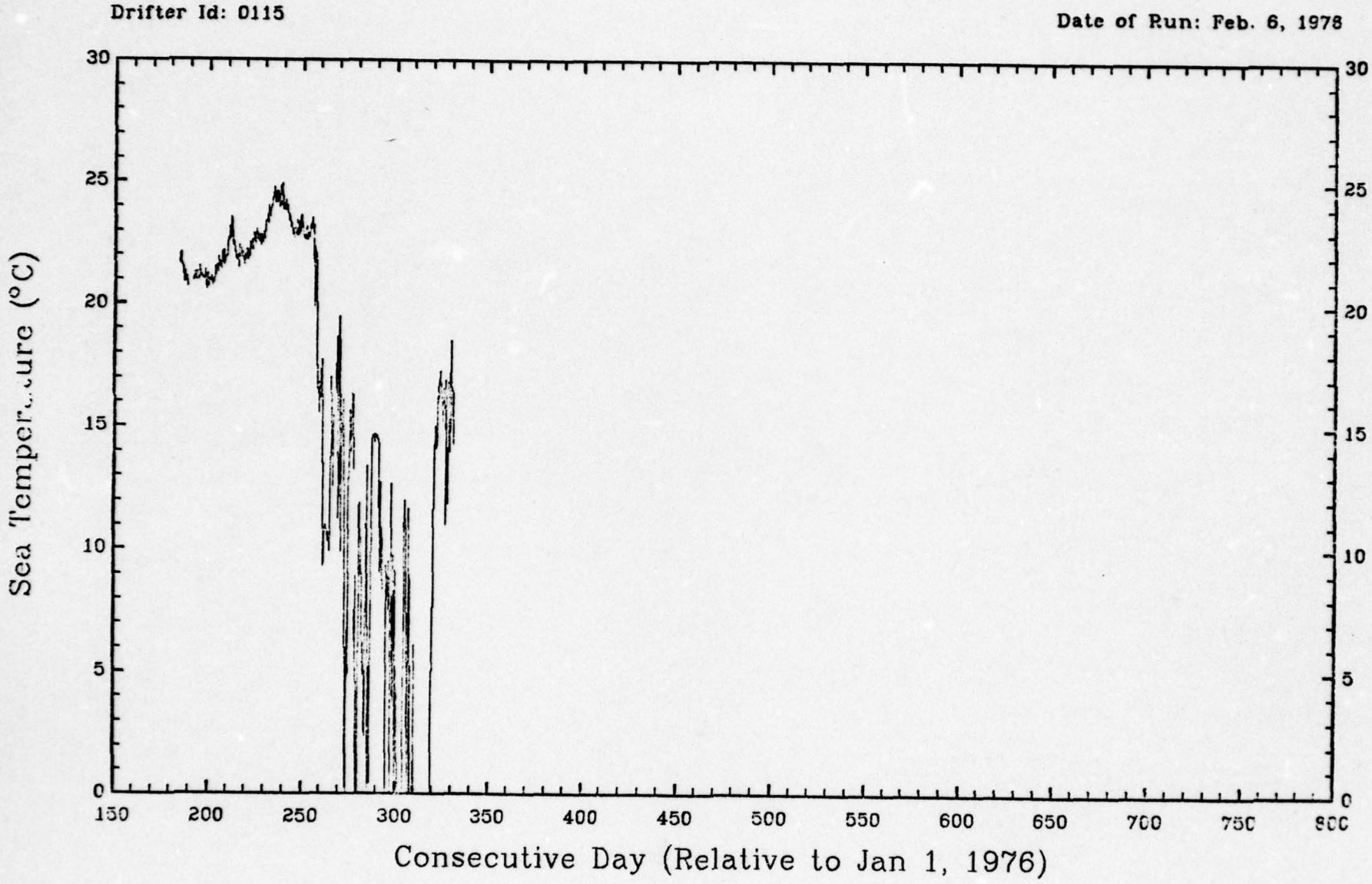


Drifter Trajectories
Velocity Checked Positions


Drifter Id: 0115
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
12
10
8
6
4
2
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0115
Date of Run: Feb. 6, 1978
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

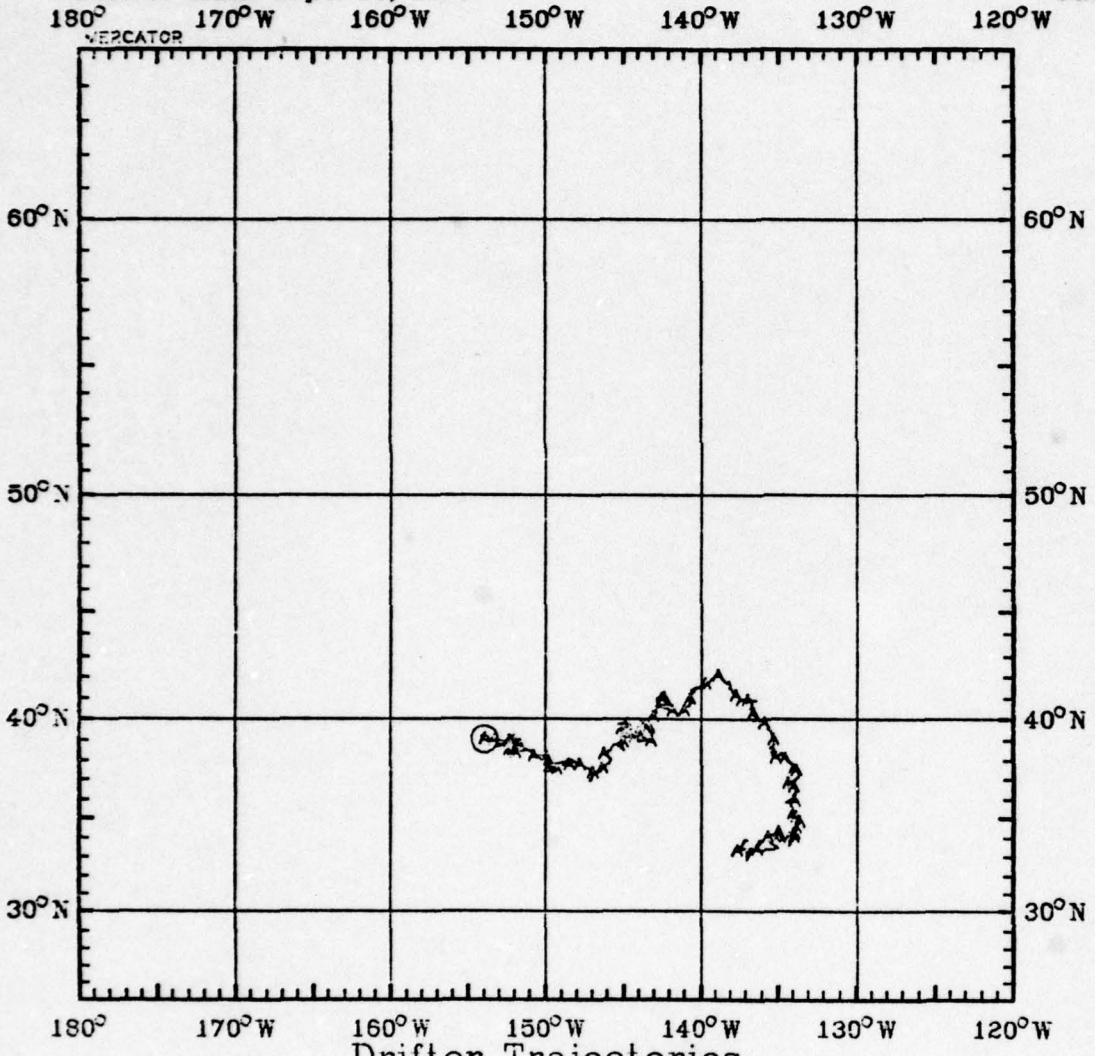

Drifter Id: 0115
Date of Run: Feb. 6, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0115
Date of Run: Feb. 6, 1978
Sea Temperature (°C)
0
5
10
15
20
25
30
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

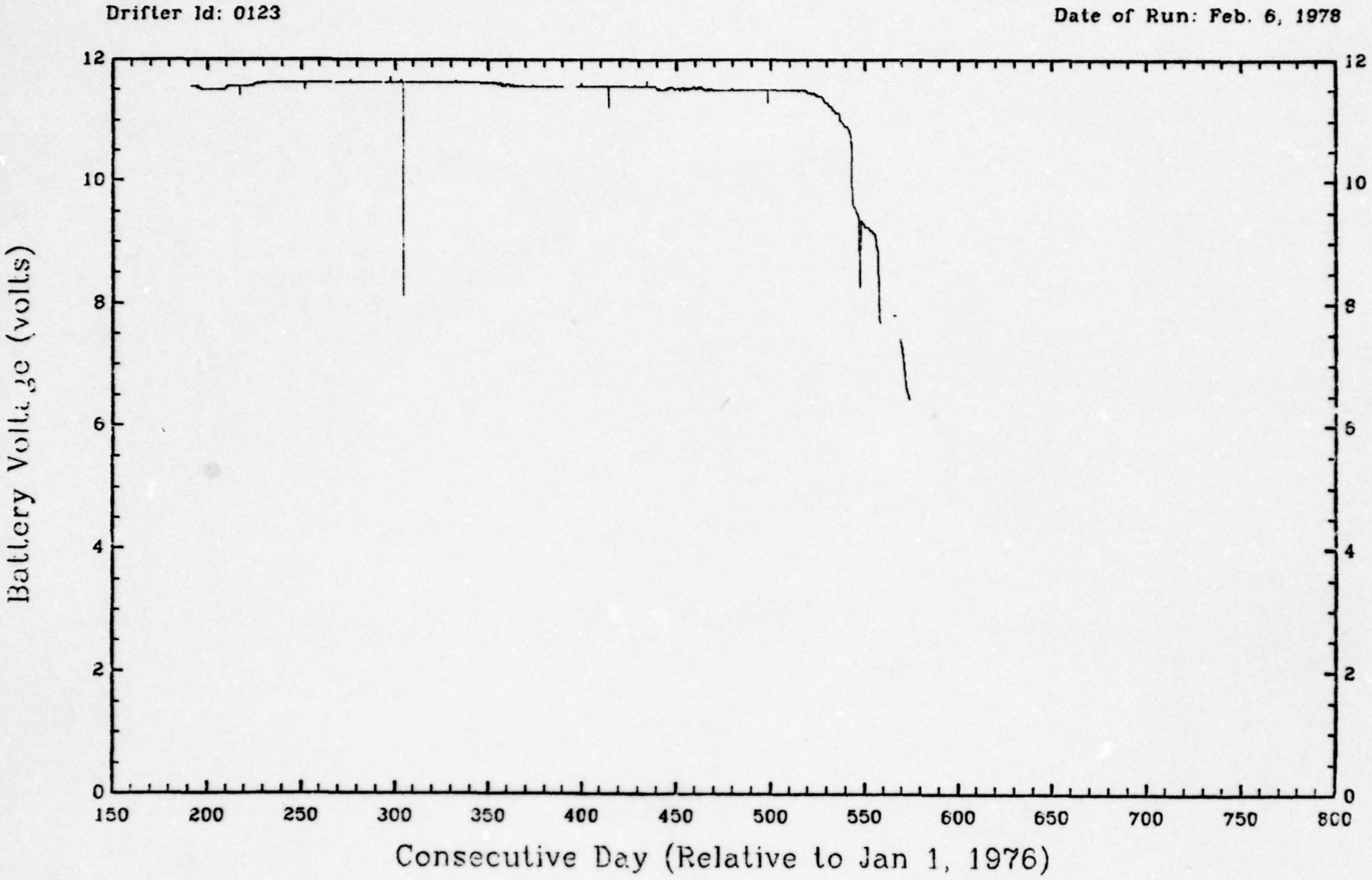
Date of Run: Sept. 15, 1977

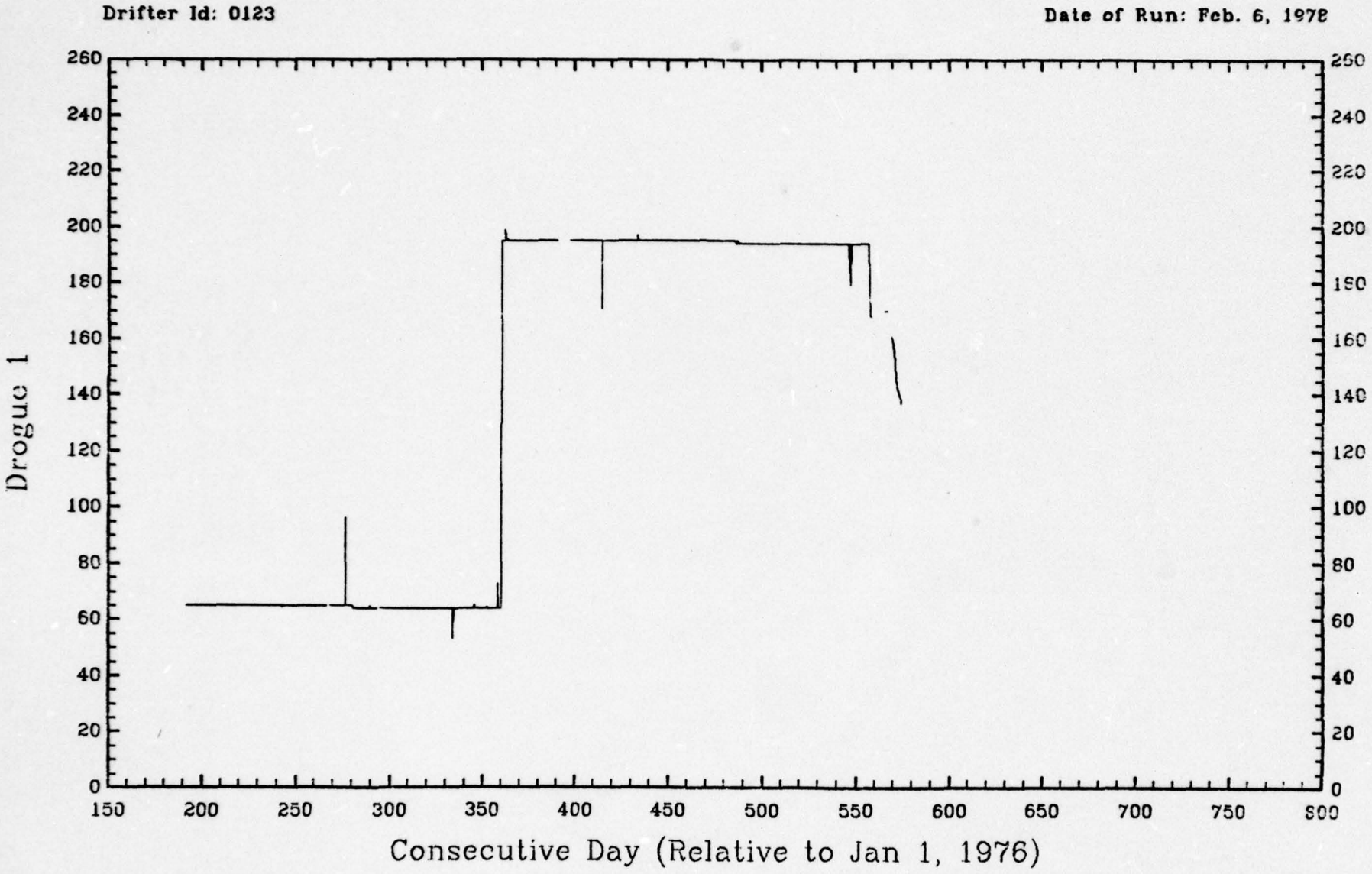
Period Covered:
June 1, 1976 to Sept. 15, 1977

Symbol	Drifter Id
A	0123



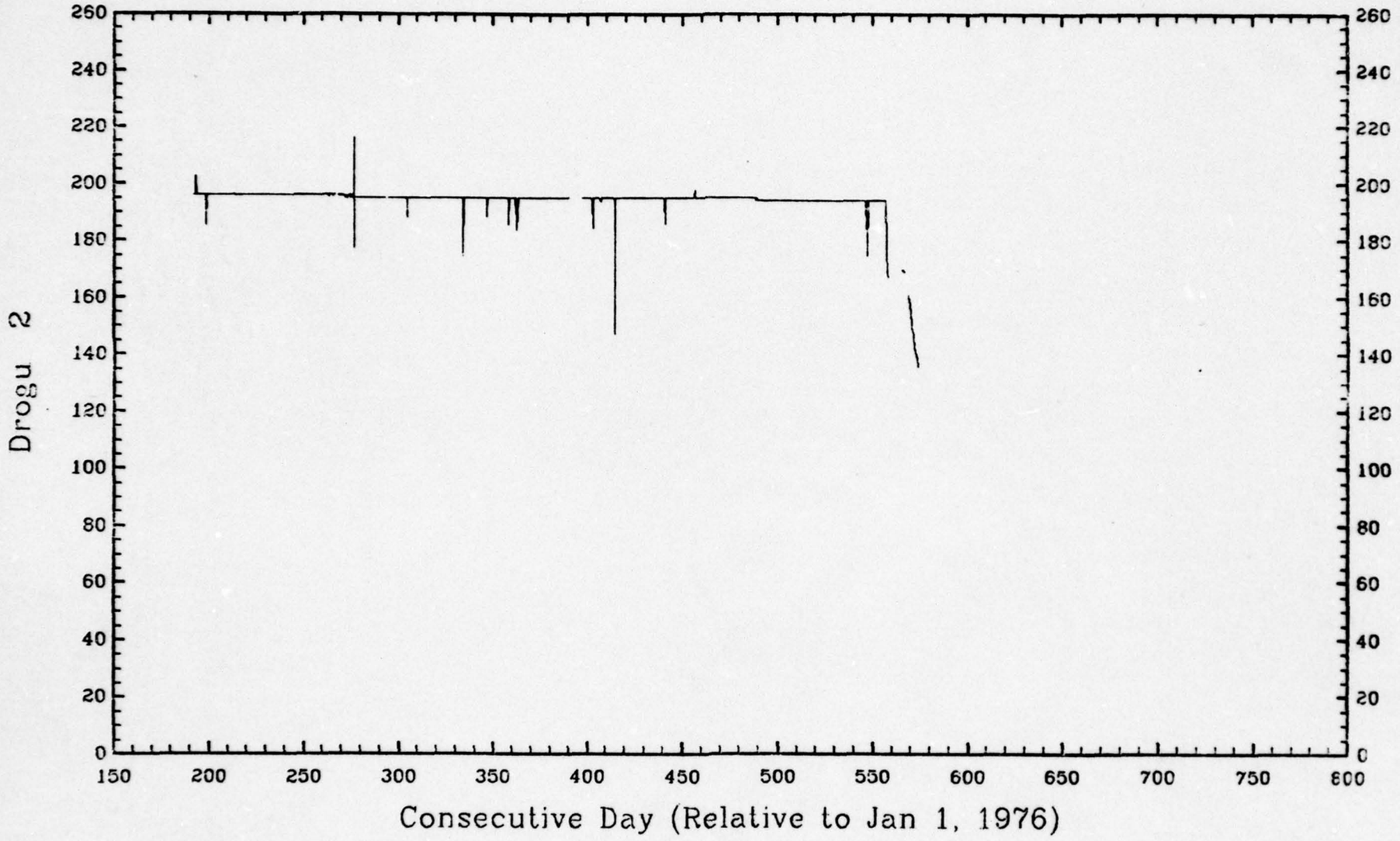
Drifter Trajectories
Velocity Checked Positions

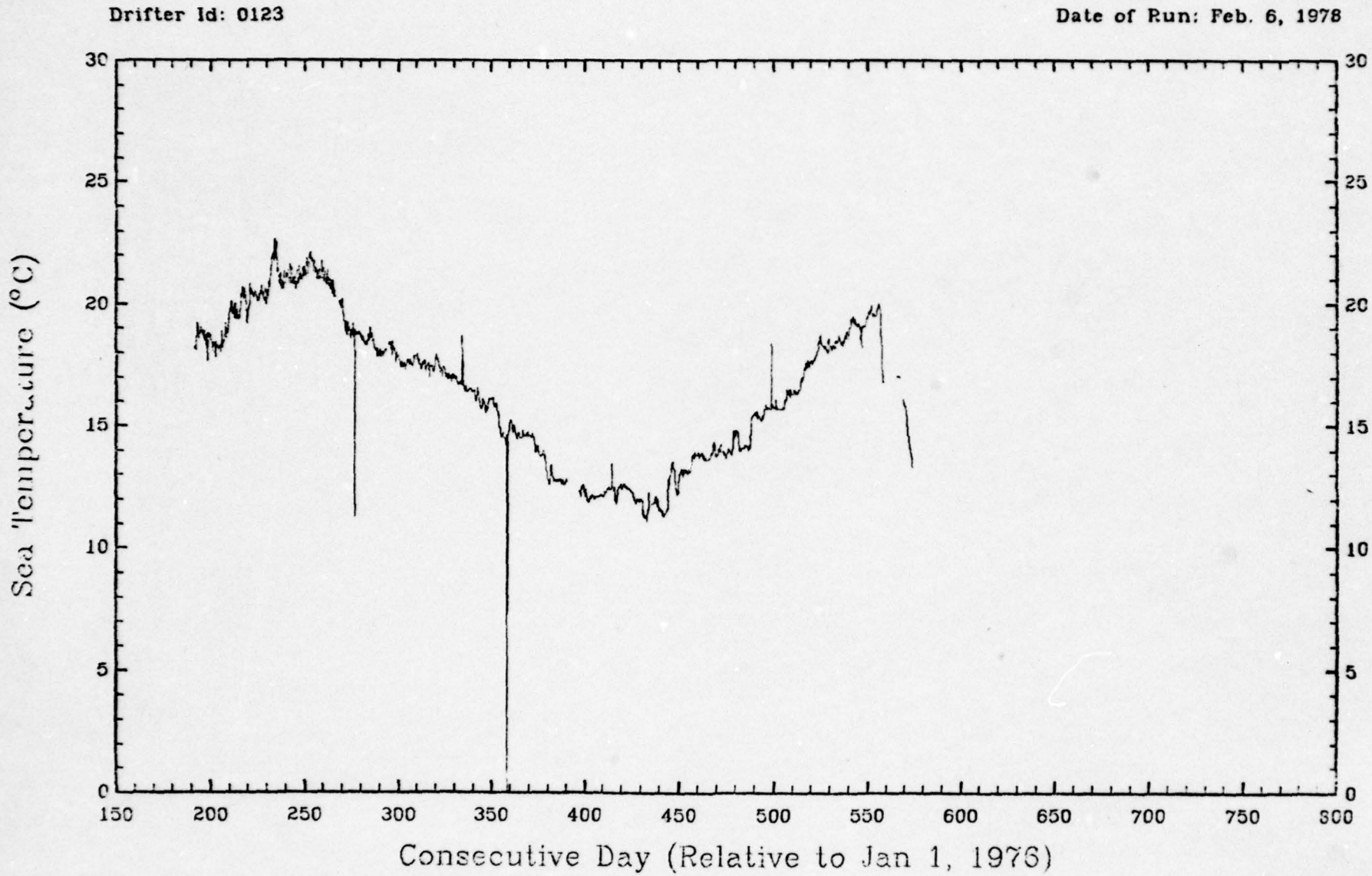

Drifter Id: 0123
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0123
Date of Run: Feb. 6, 1978
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0123

Date of Run: Feb. 6, 1978

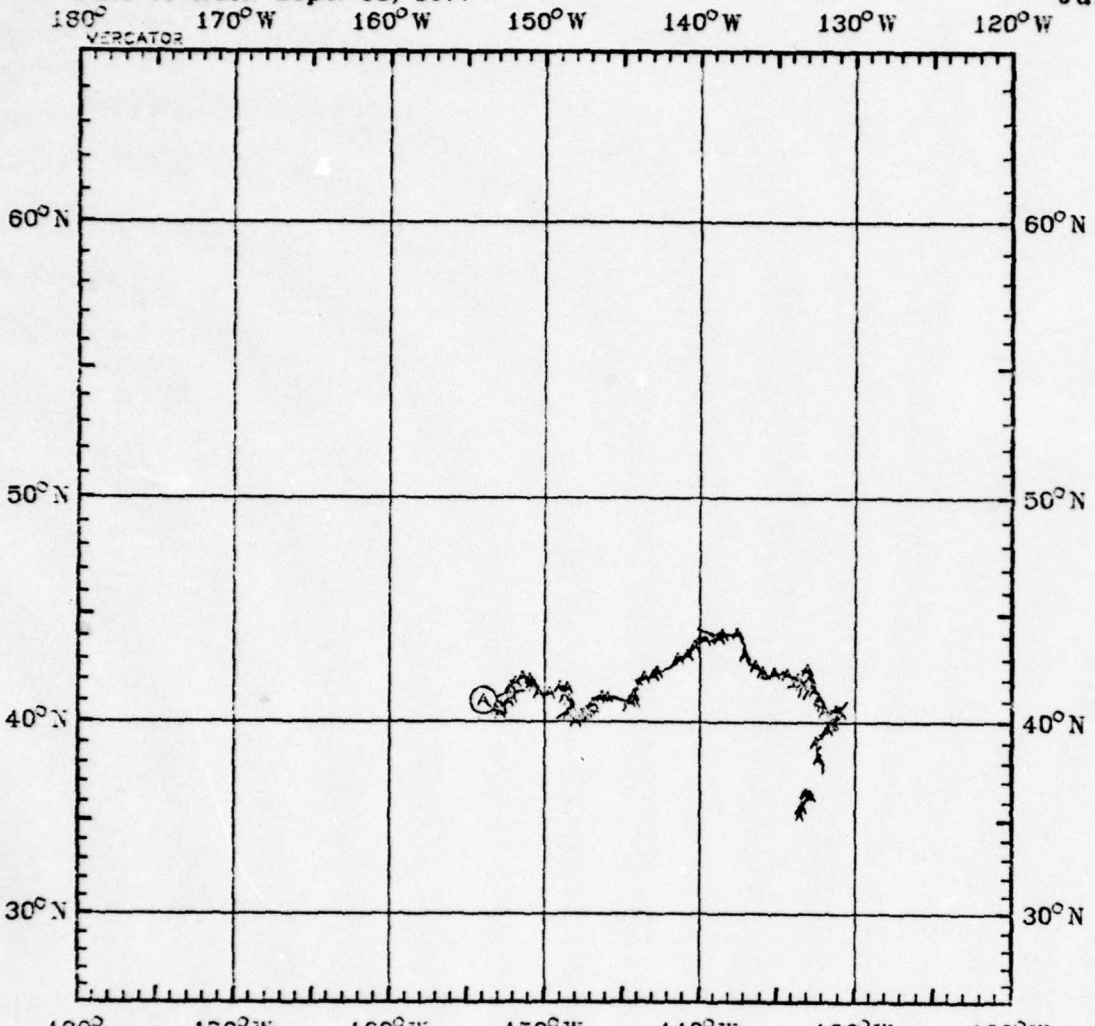



Drifter Id: 0123
Date of Run: Feb. 6, 1978
Sea Temperature (°C)
30
25
20
15
10
5
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1978)

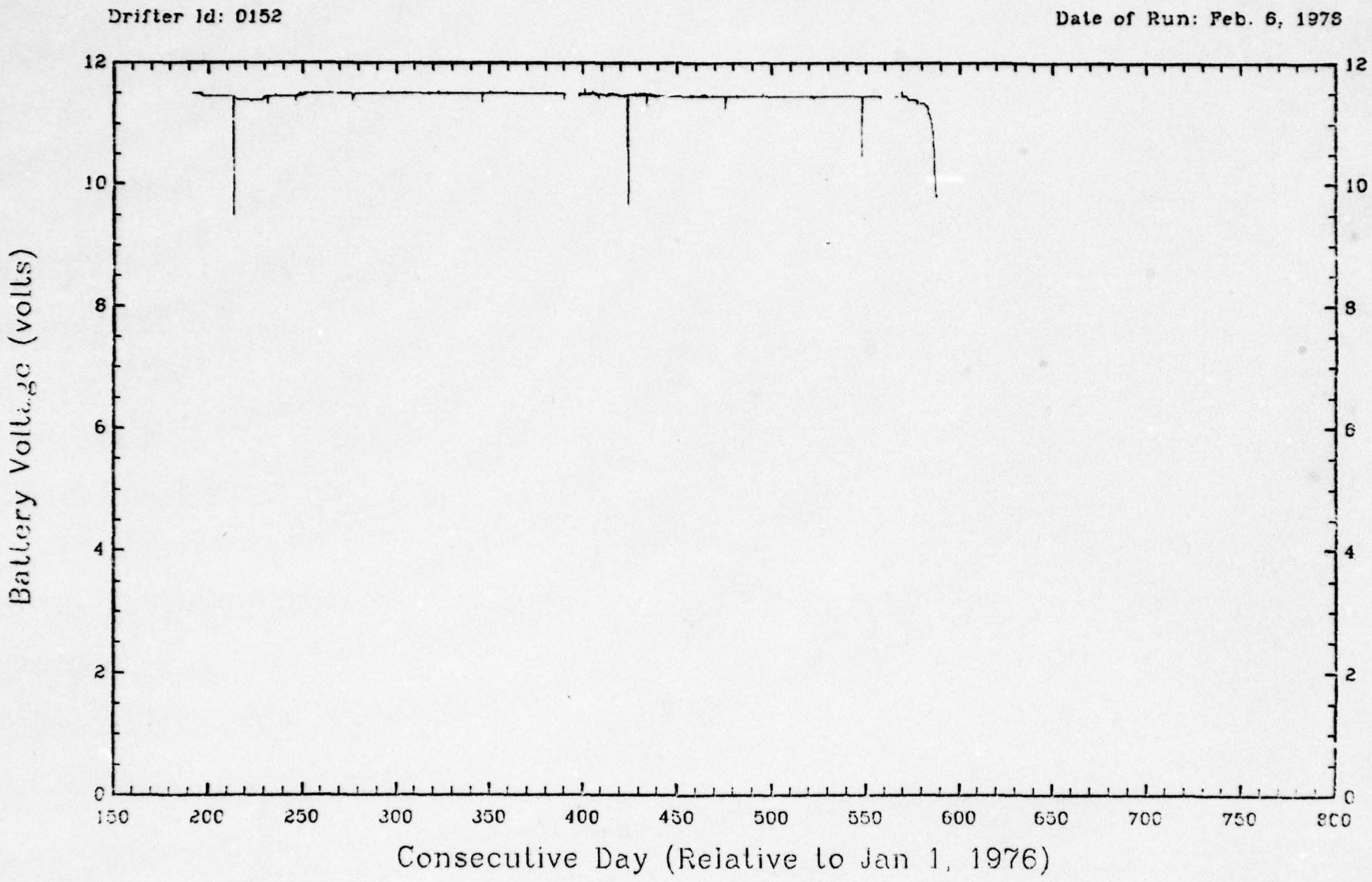
Date of Run: Sept. 15, 1977

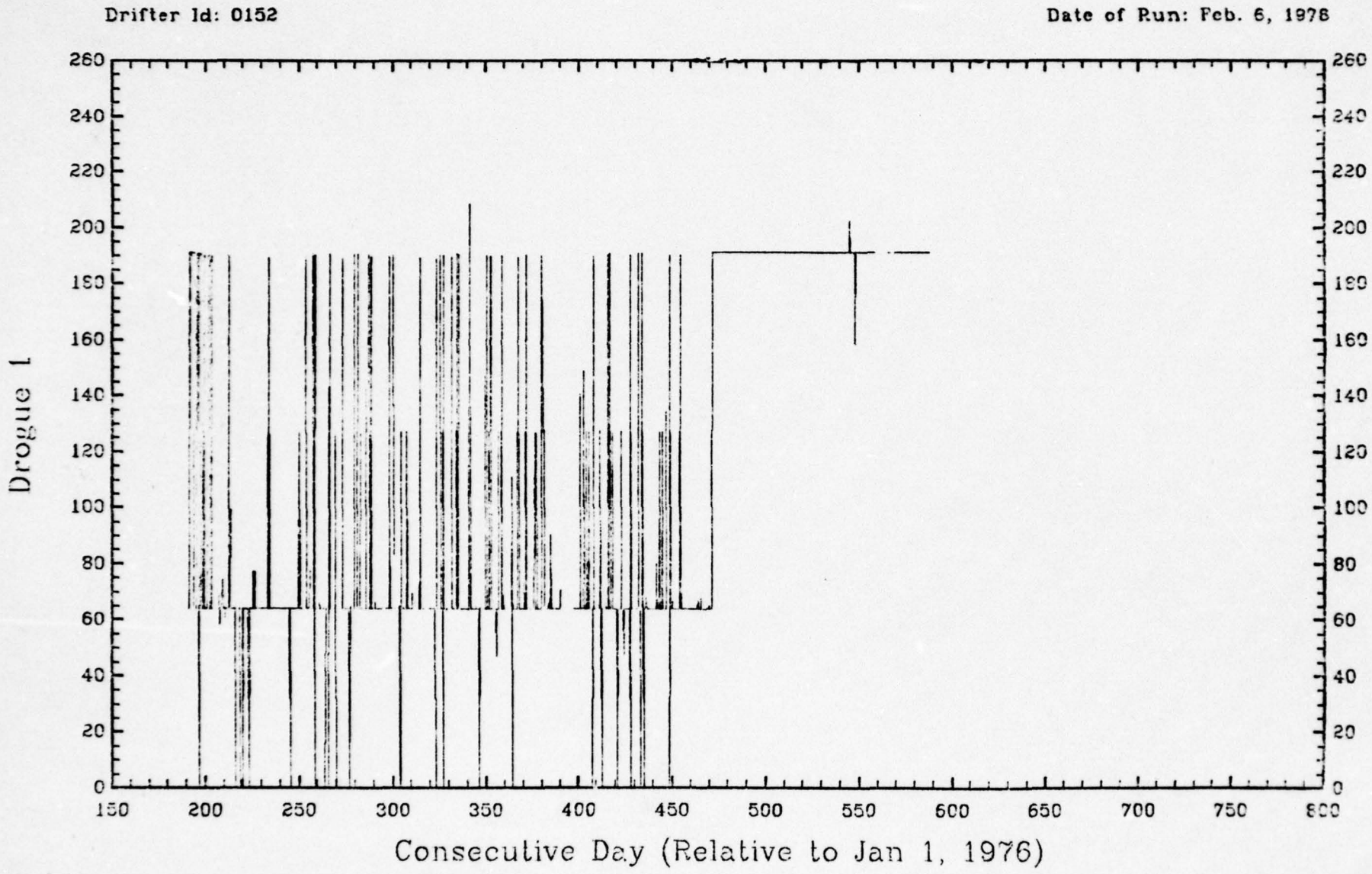
Period Covered:
June 1, 1976 to Sept. 15, 1977

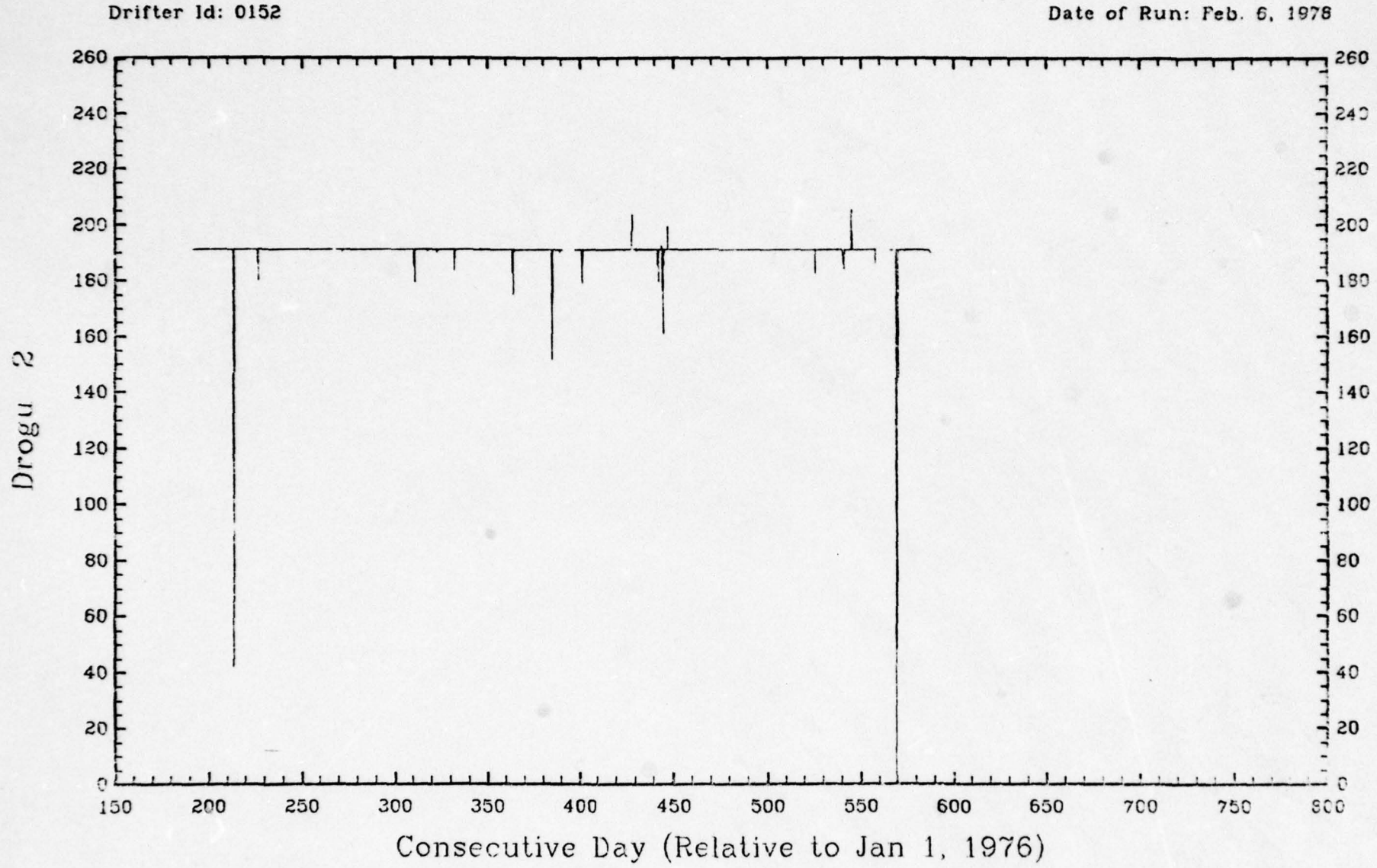
Symbol	Drifter Id
A	0152



Drifter Trajectories
Velocity Checked Positions

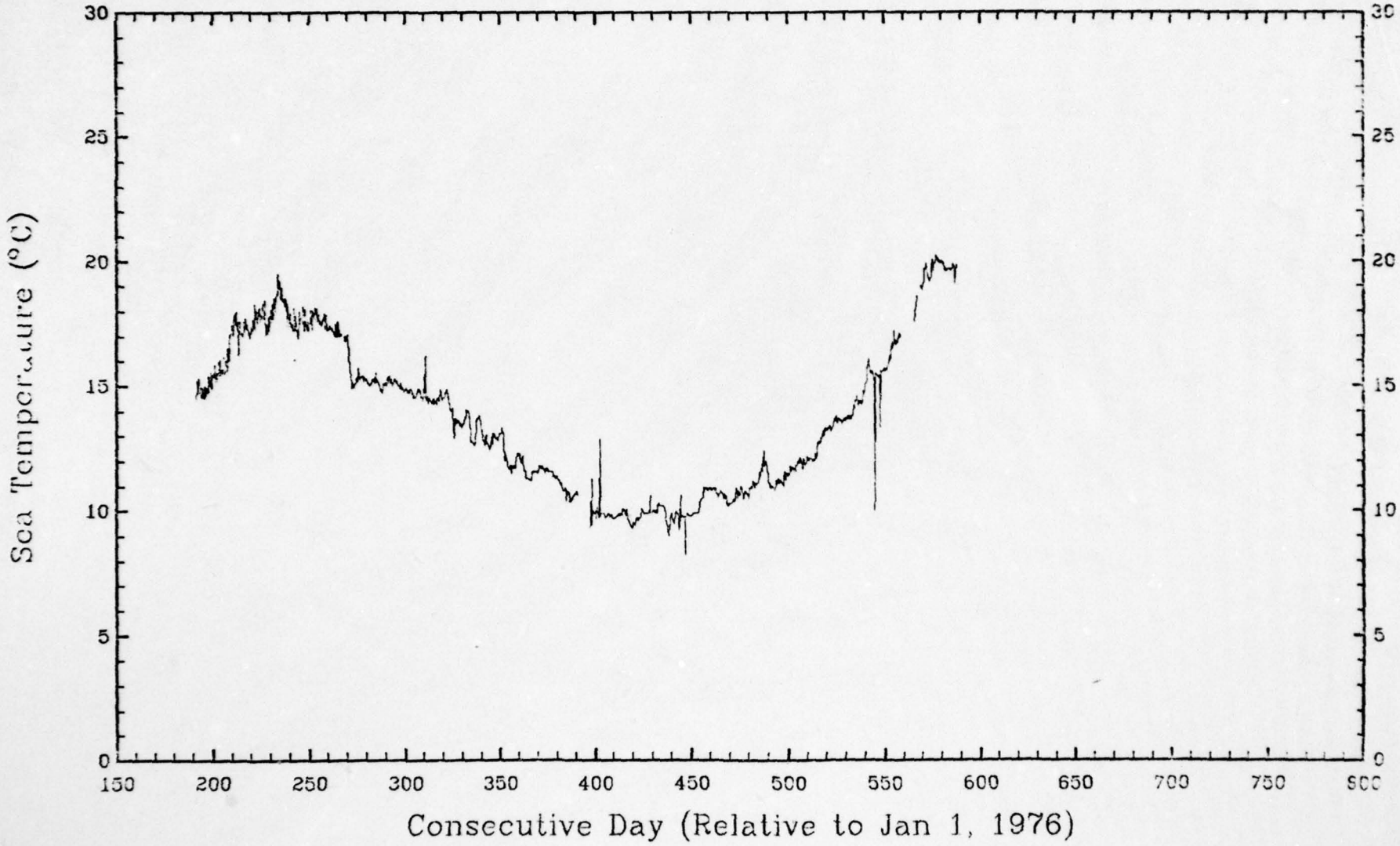

Drifter Id: 0152
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0152
Date of Run: Feb. 6, 1976
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0152
Date of Run: Feb. 6, 1978
Drogu 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0152

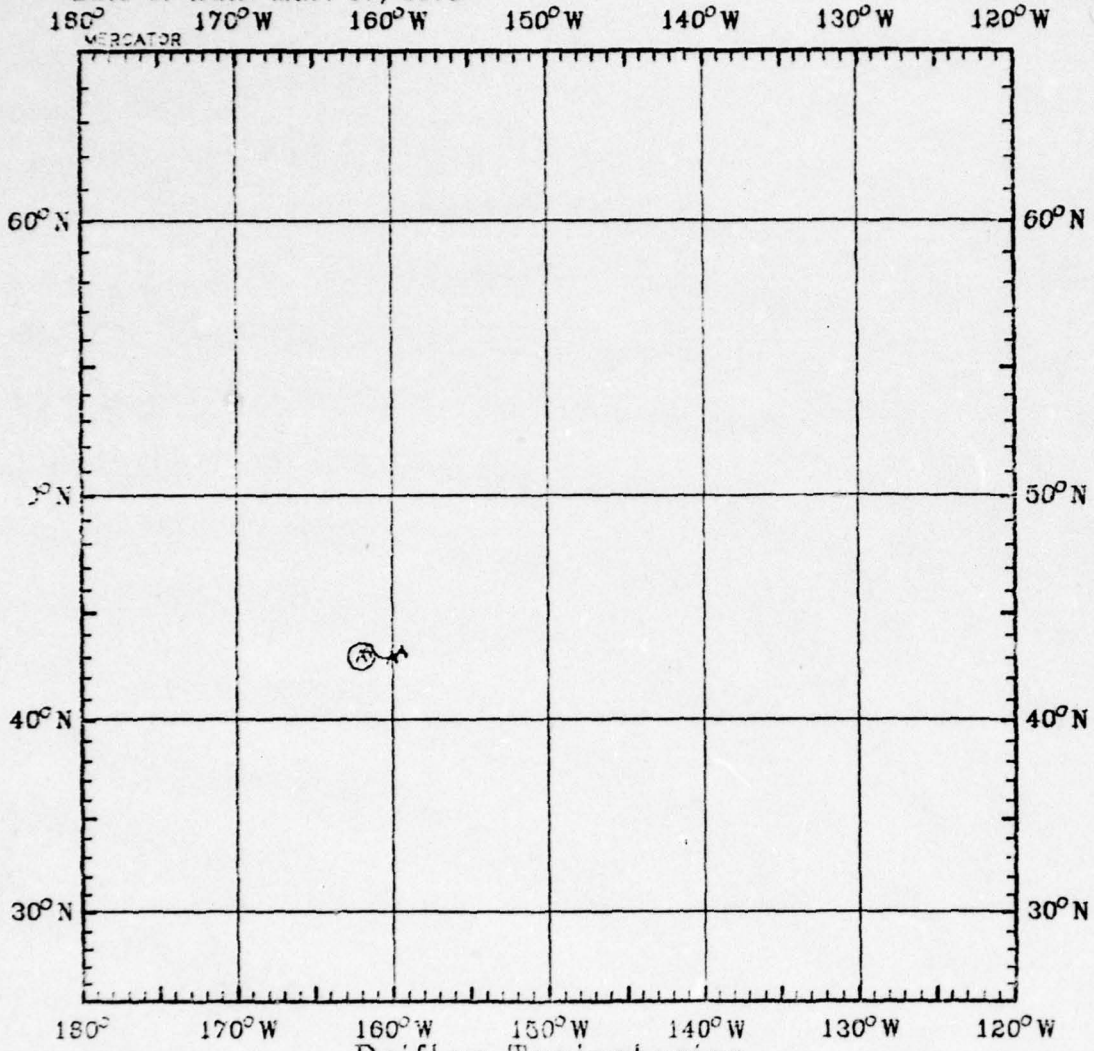
Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1976

Period Covered:
July 3, 1976 to Aug. 8, 1976

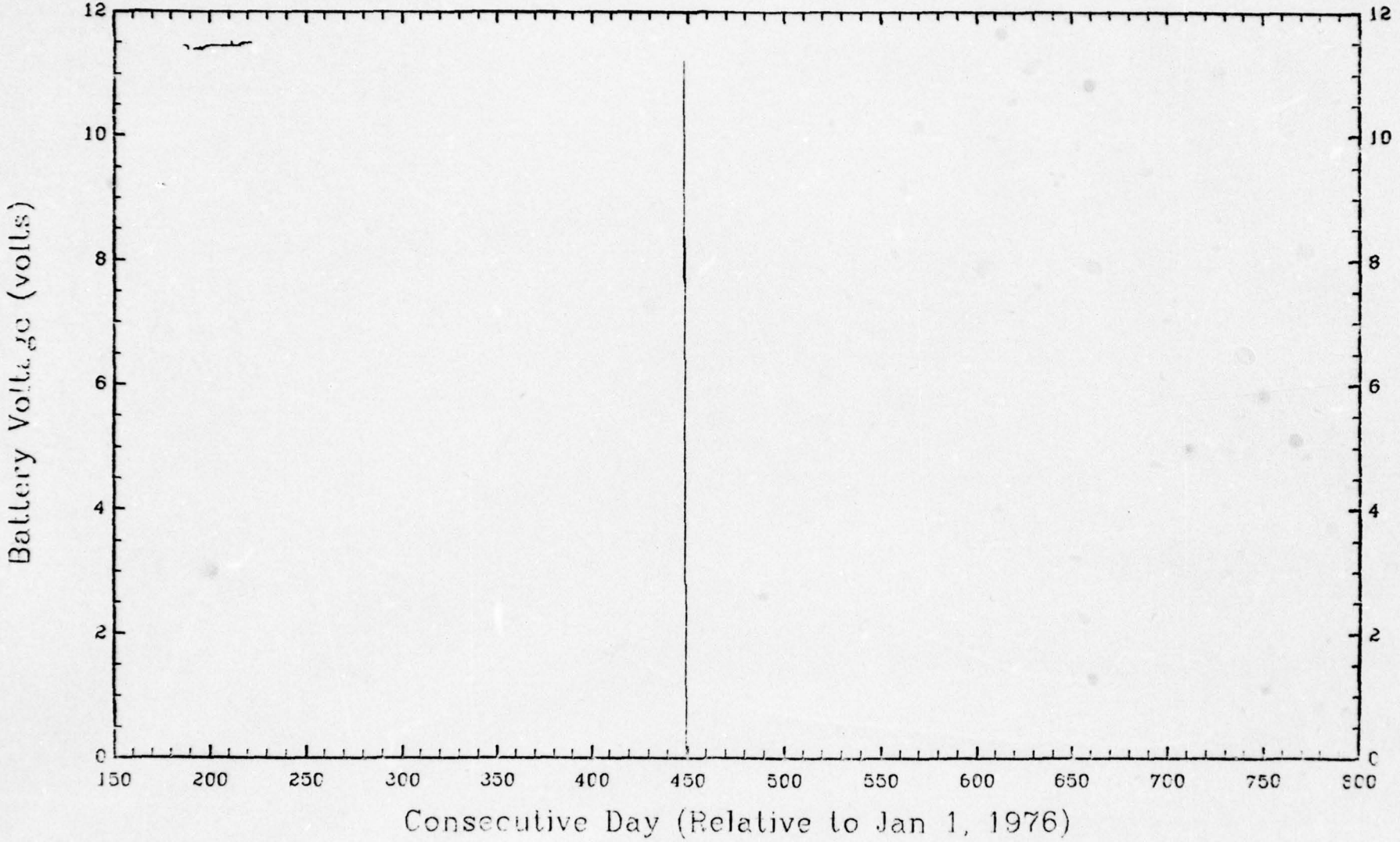
Symbol	Drifter Id
A	0164



Drifter Trajectories
Positions Computed by Interpolation

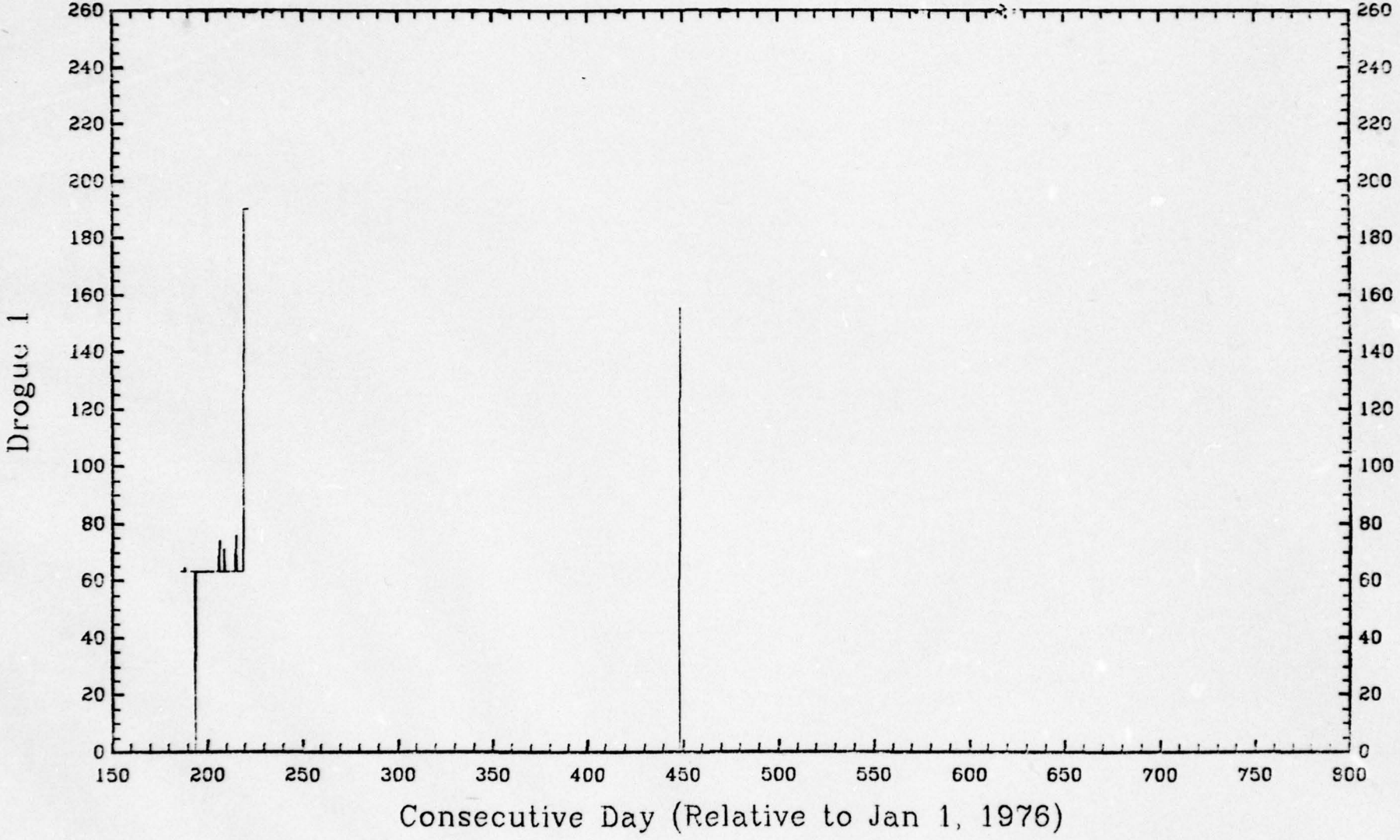
Drifter Id: 0164

Date of Run: Feb. 6, 1976



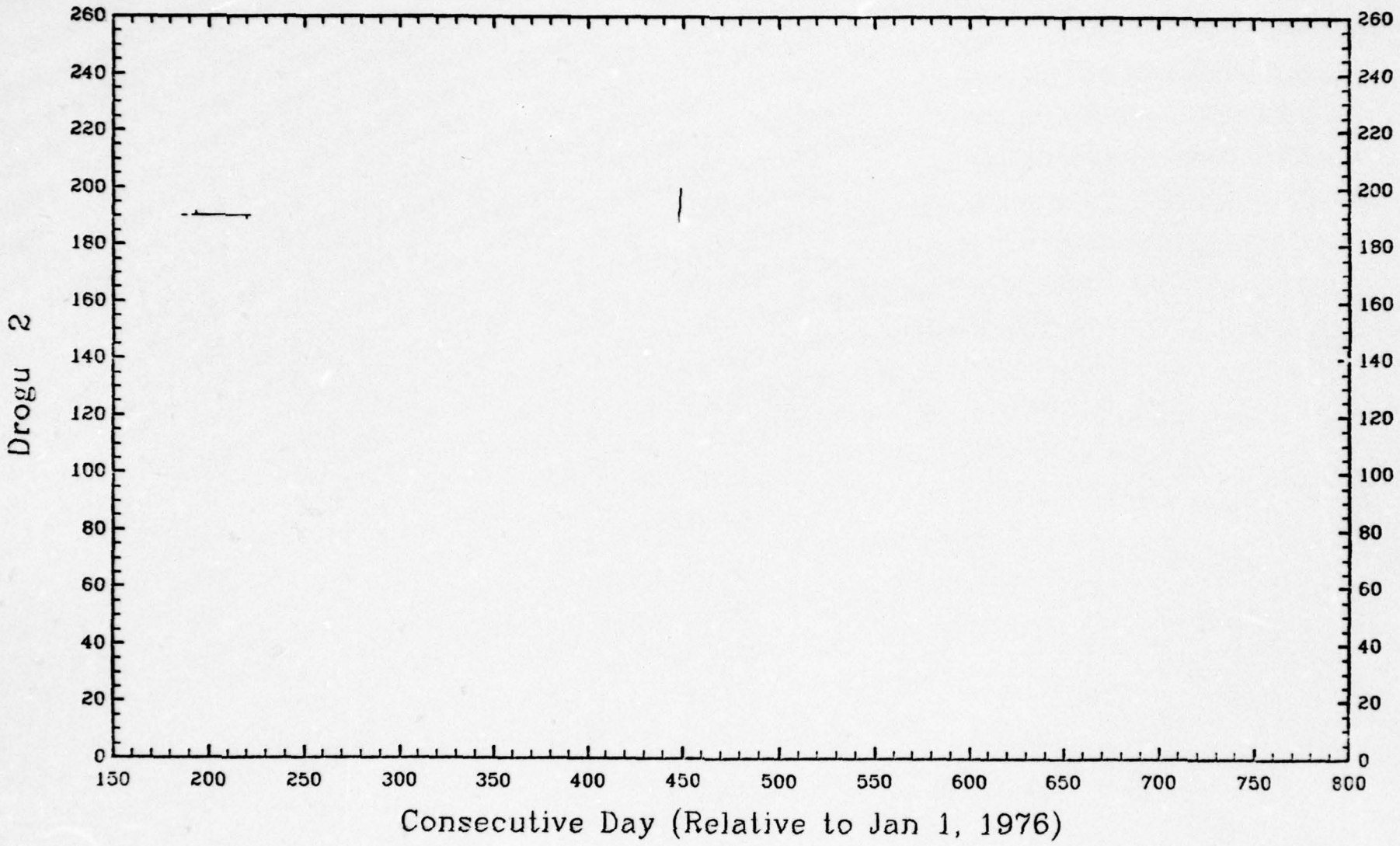
Drifter Id: 0164

Date of Run: Feb. 6, 1978



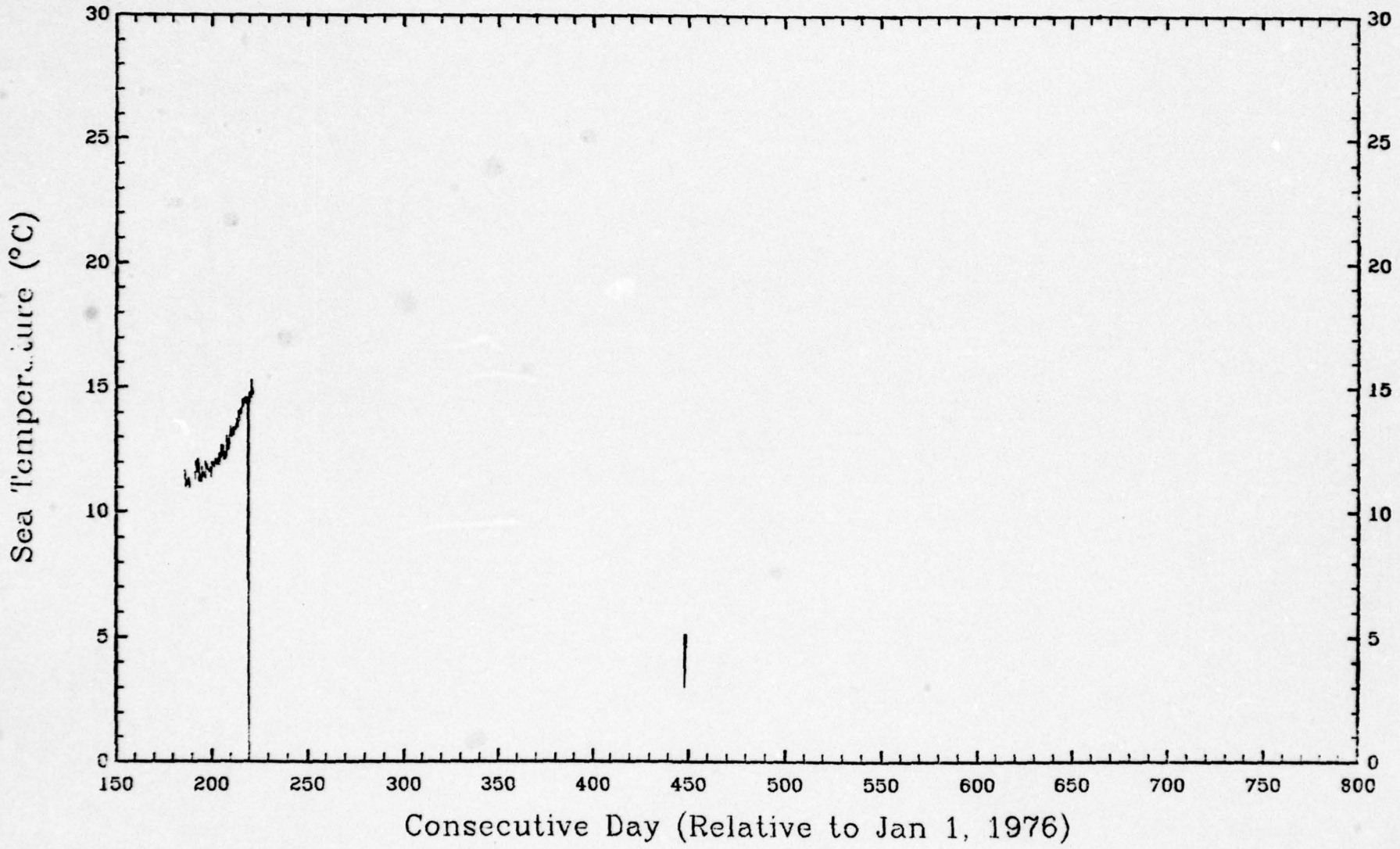
Drifter Id: 0164

Date of Run: Feb. 6, 1978



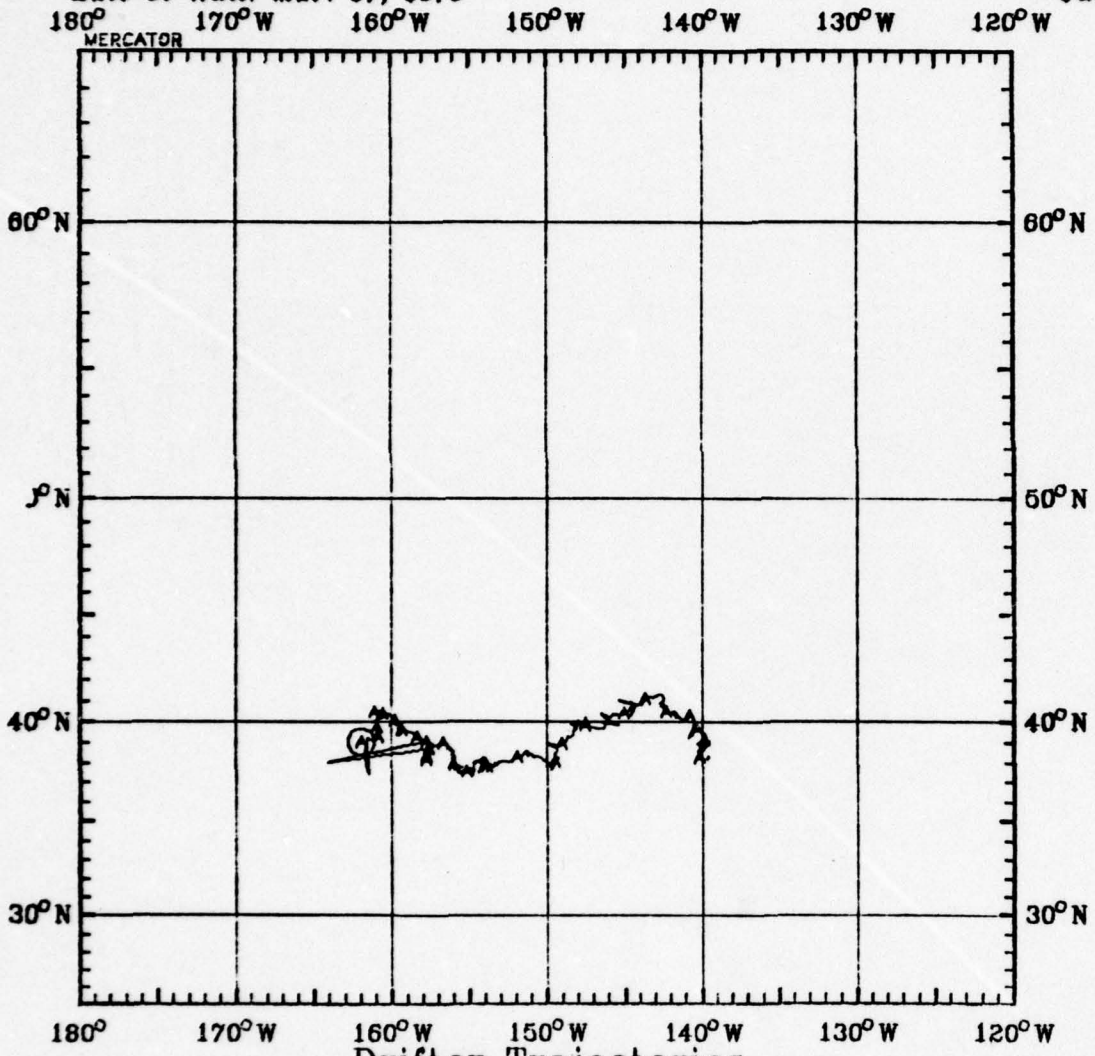
Drifter Id: 0164

Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1978

Period Covered:
June 1, 1976 to Mar. 17, 1978



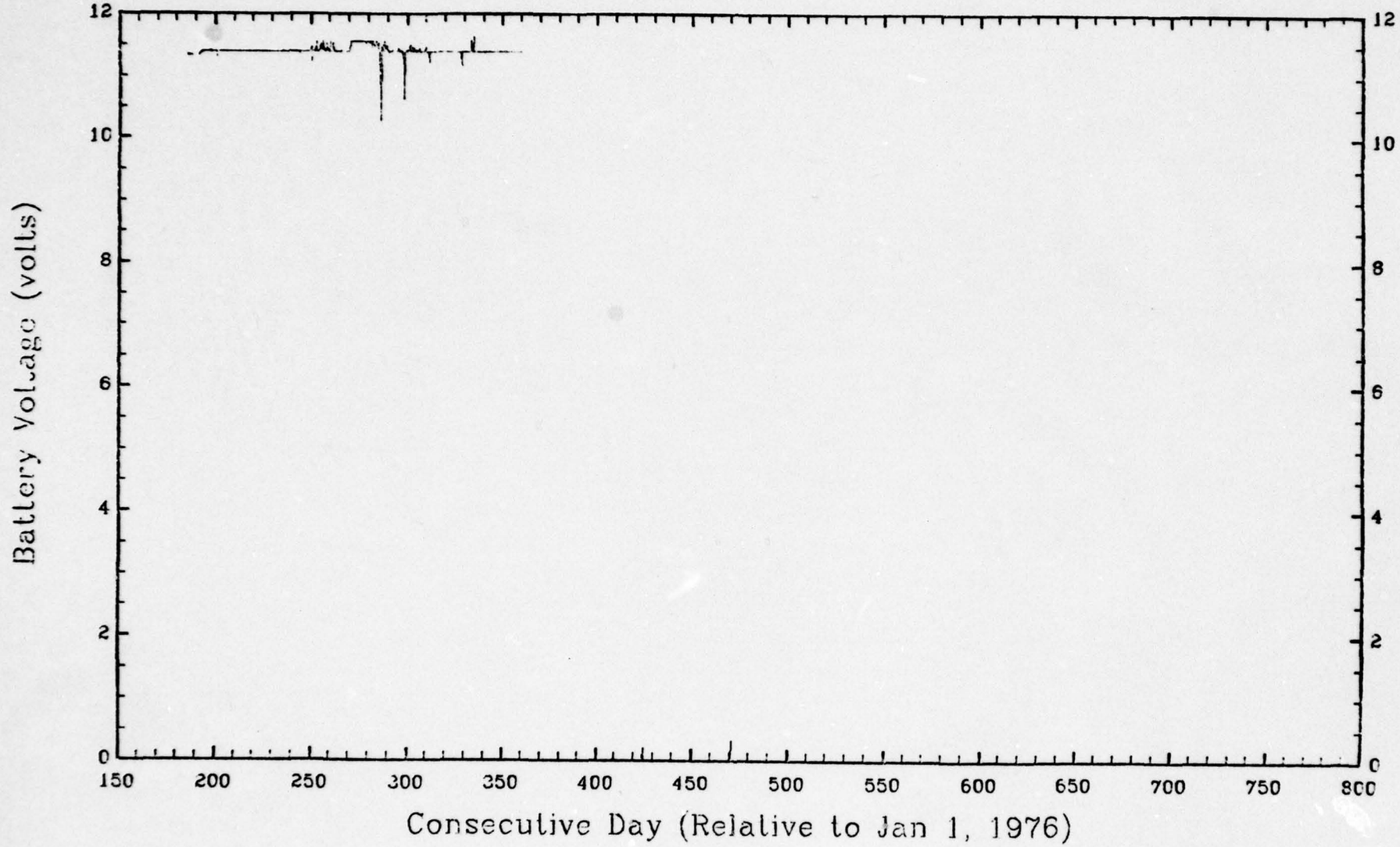
Symbol	Drifter Id
^	0213

Drifter Trajectories

Positions Computed by Interpolation

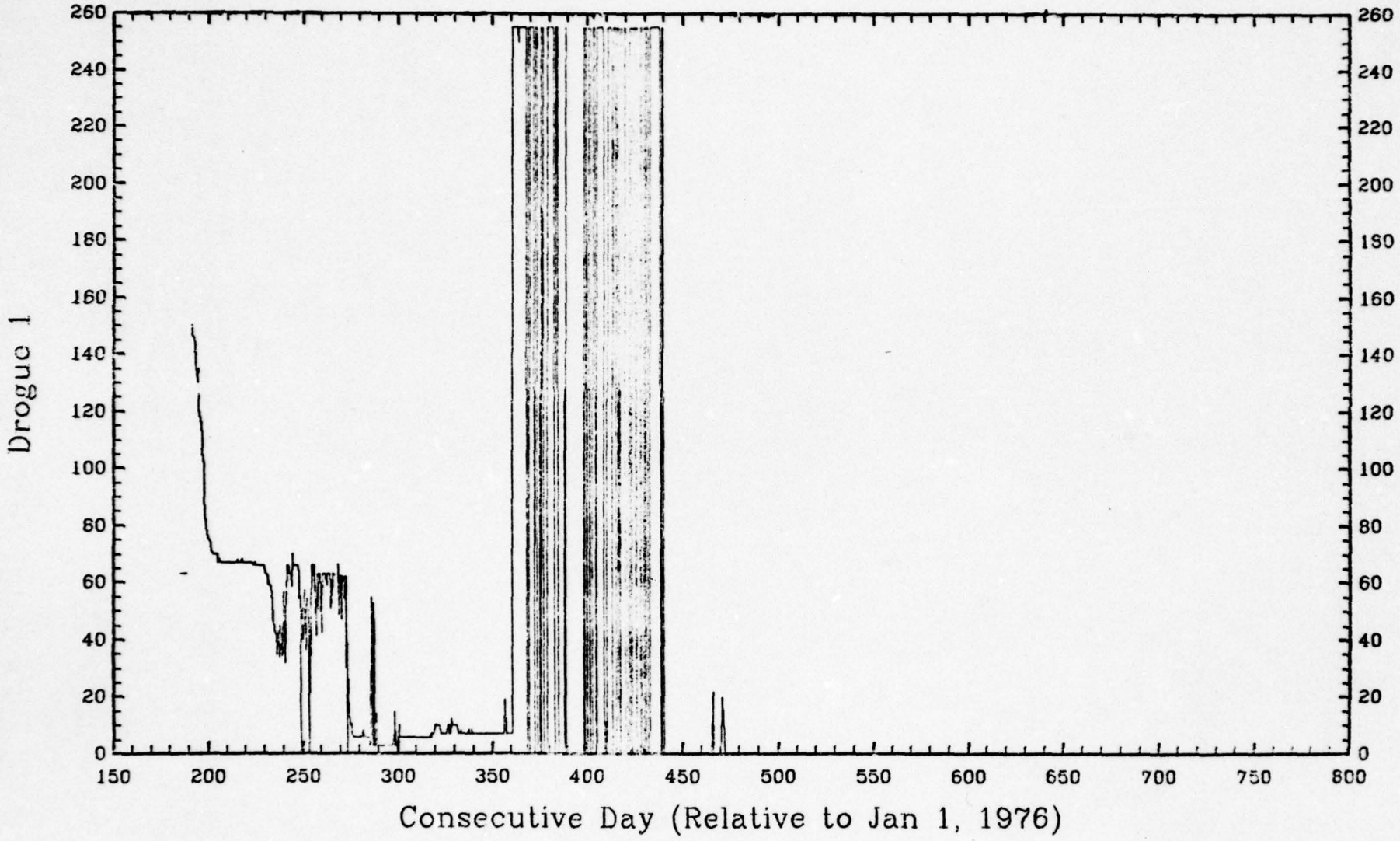
Drifter Id: 0213

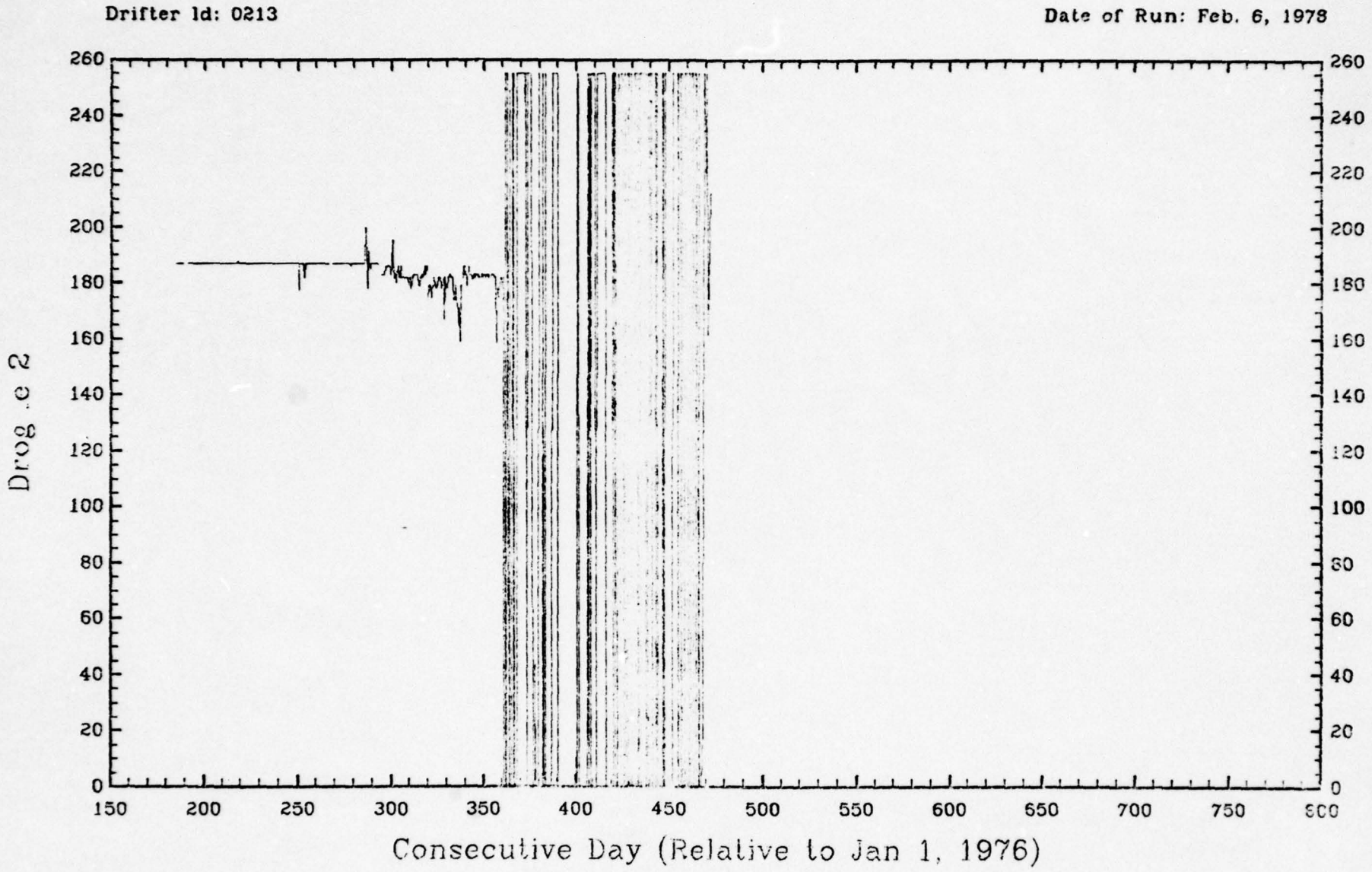
Date of Run: Feb. 6, 1978



Drifter Id: 0213

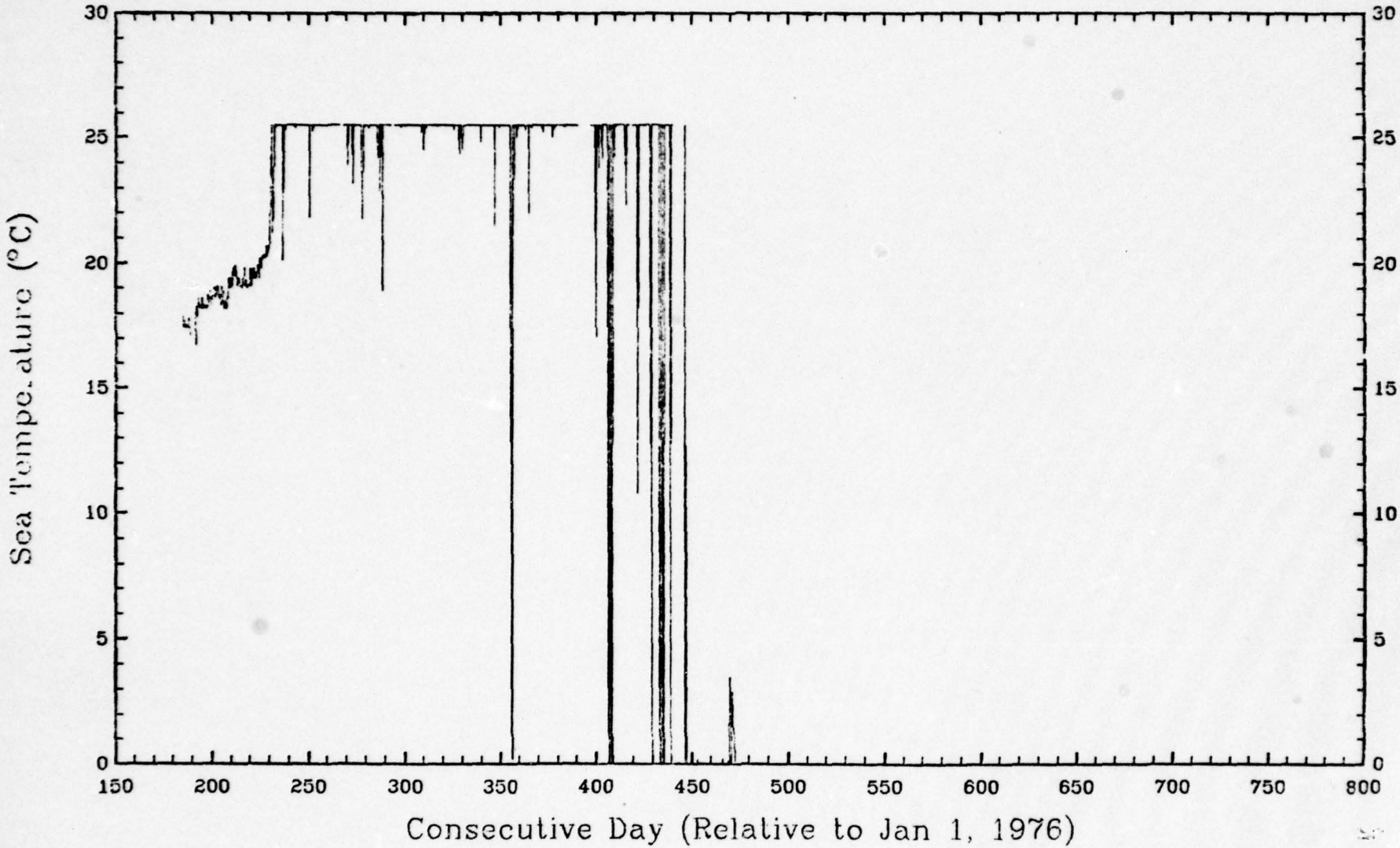
Date of Run: Feb. 6, 1978




Drifter Id: 0213
Date of Run: Feb. 6, 1978
Drog.e 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

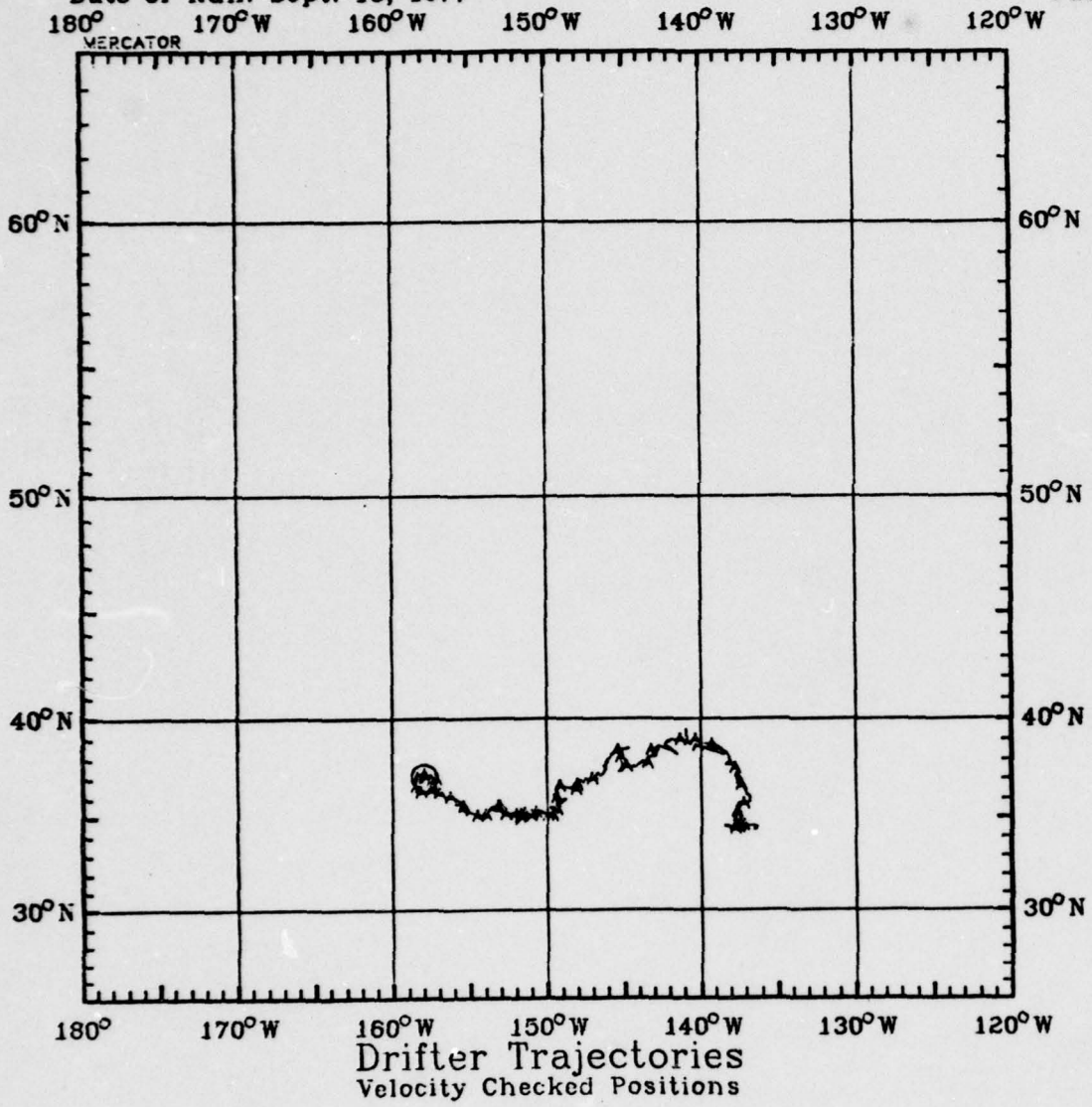
Drifter Id: 0213

Date of Run: Feb. 6, 1976



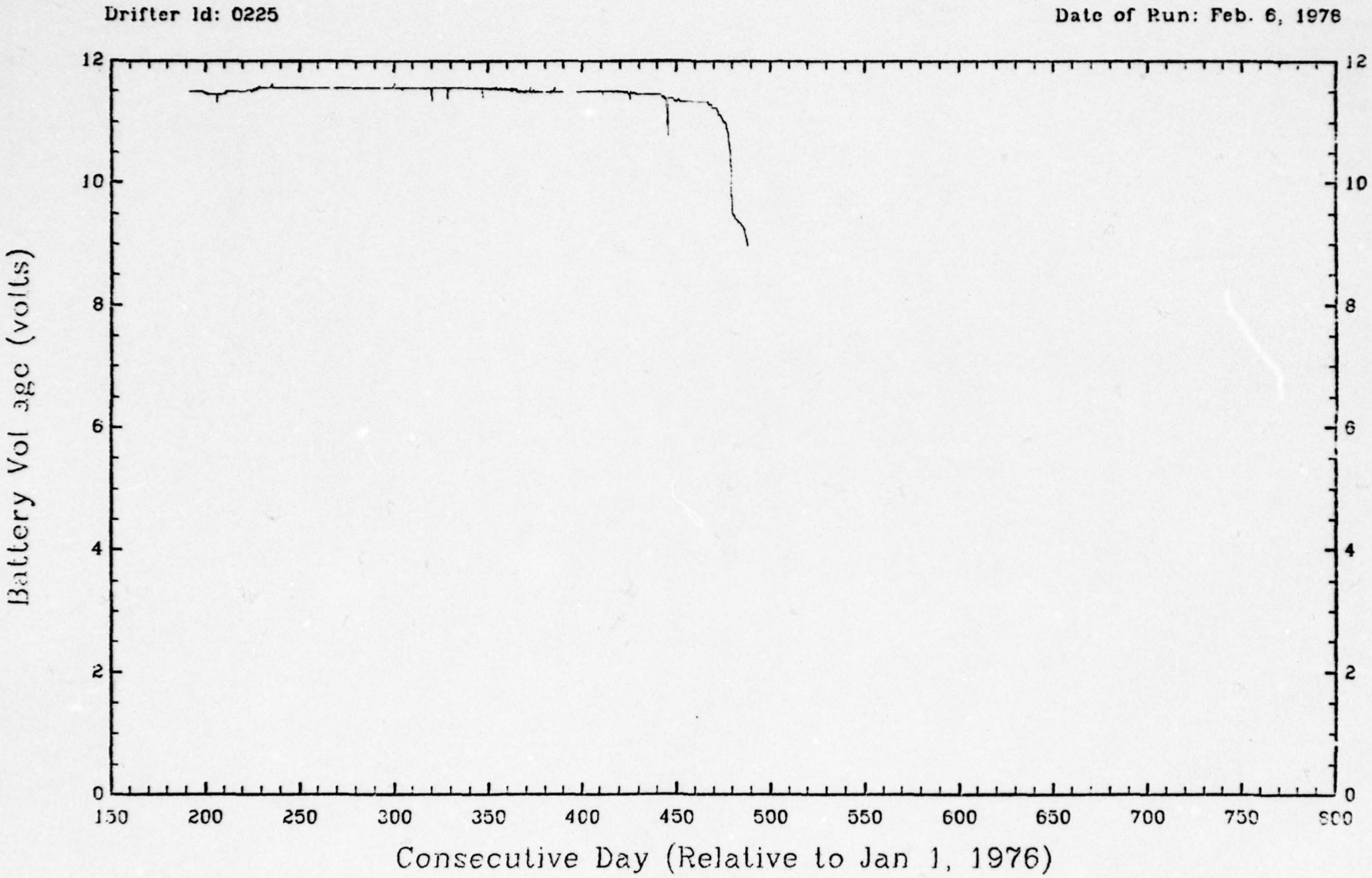
Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977



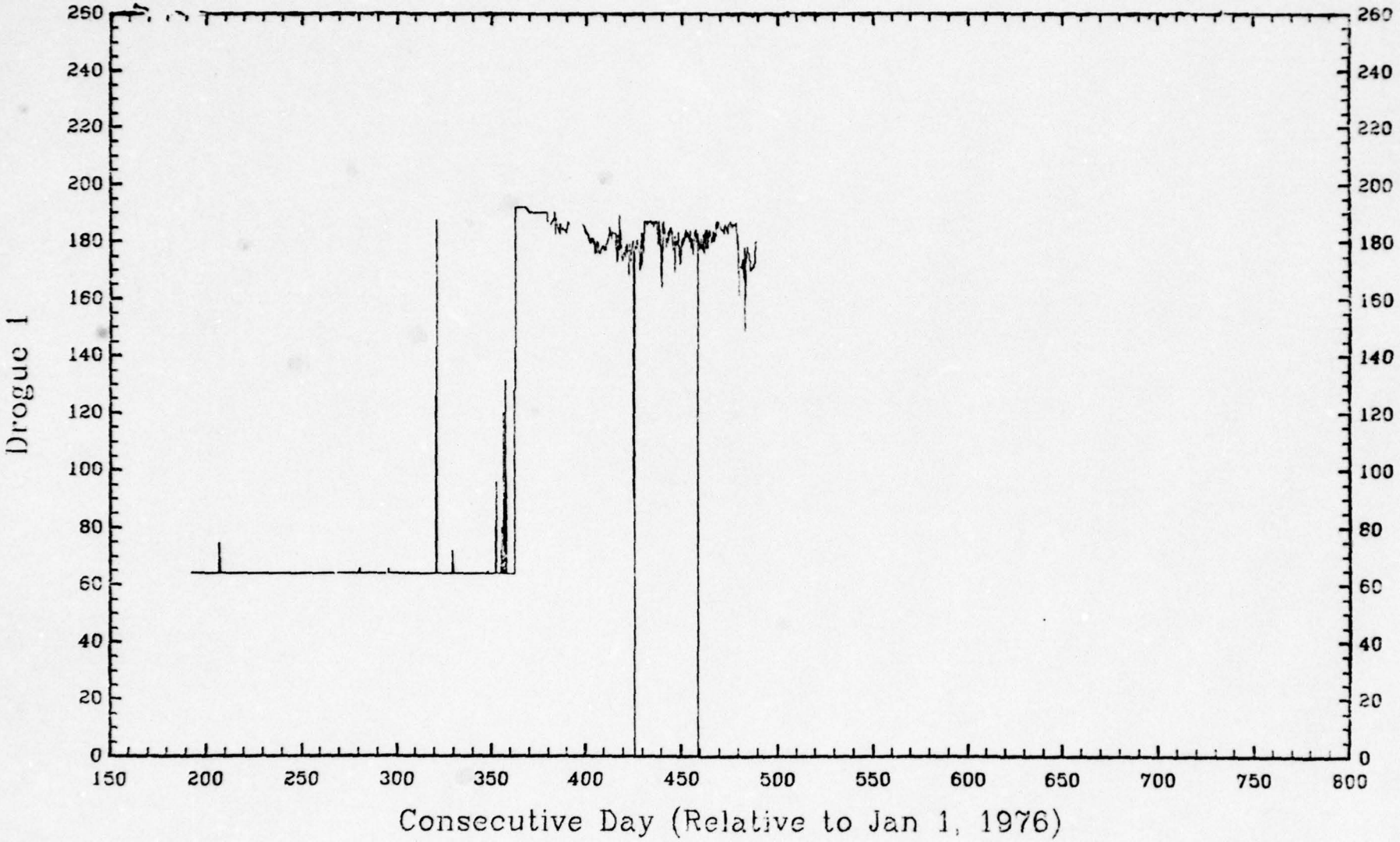
Symbol	Drifter Id
A	0225

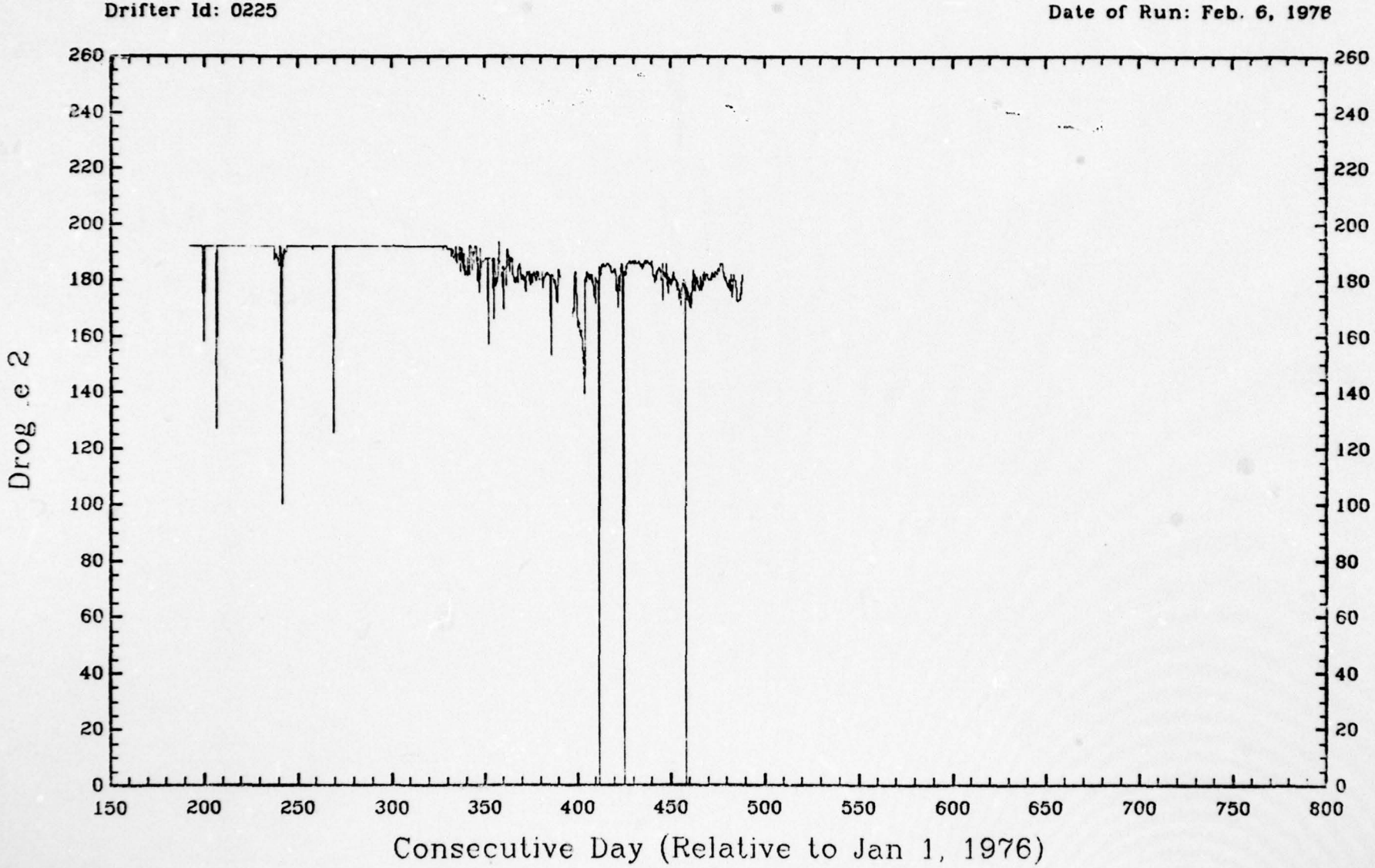
Drifter Trajectories
Velocity Checked Positions


Drifter Id: 0225
Date of Run: Feb. 6, 1976
Battery Voltage (volts)
12
10
8
6
4
2
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0225

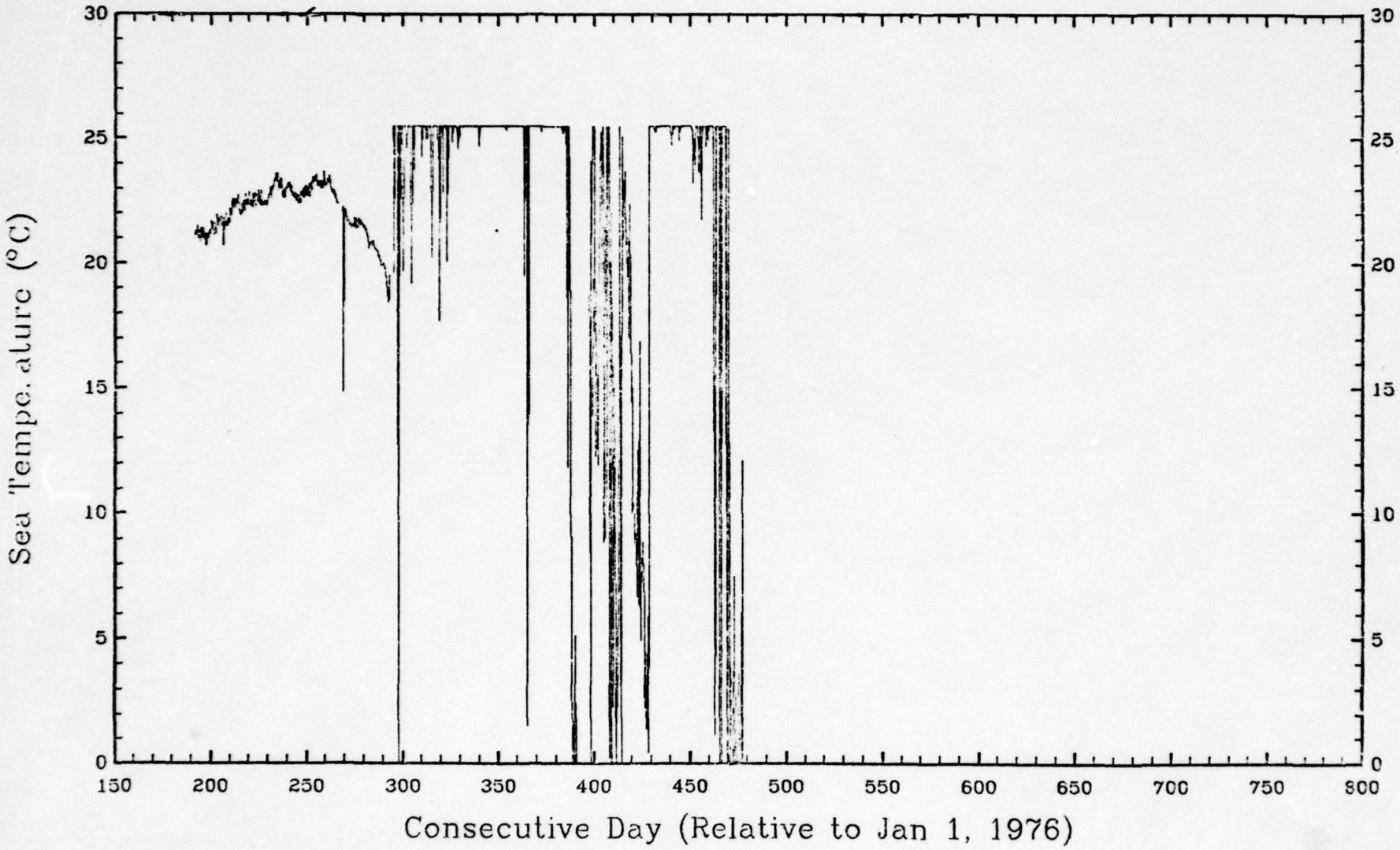
Date of Run: Feb. 6, 1978




Drifter Id: 0225
Date of Run: Feb. 6, 1978
Drog e 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

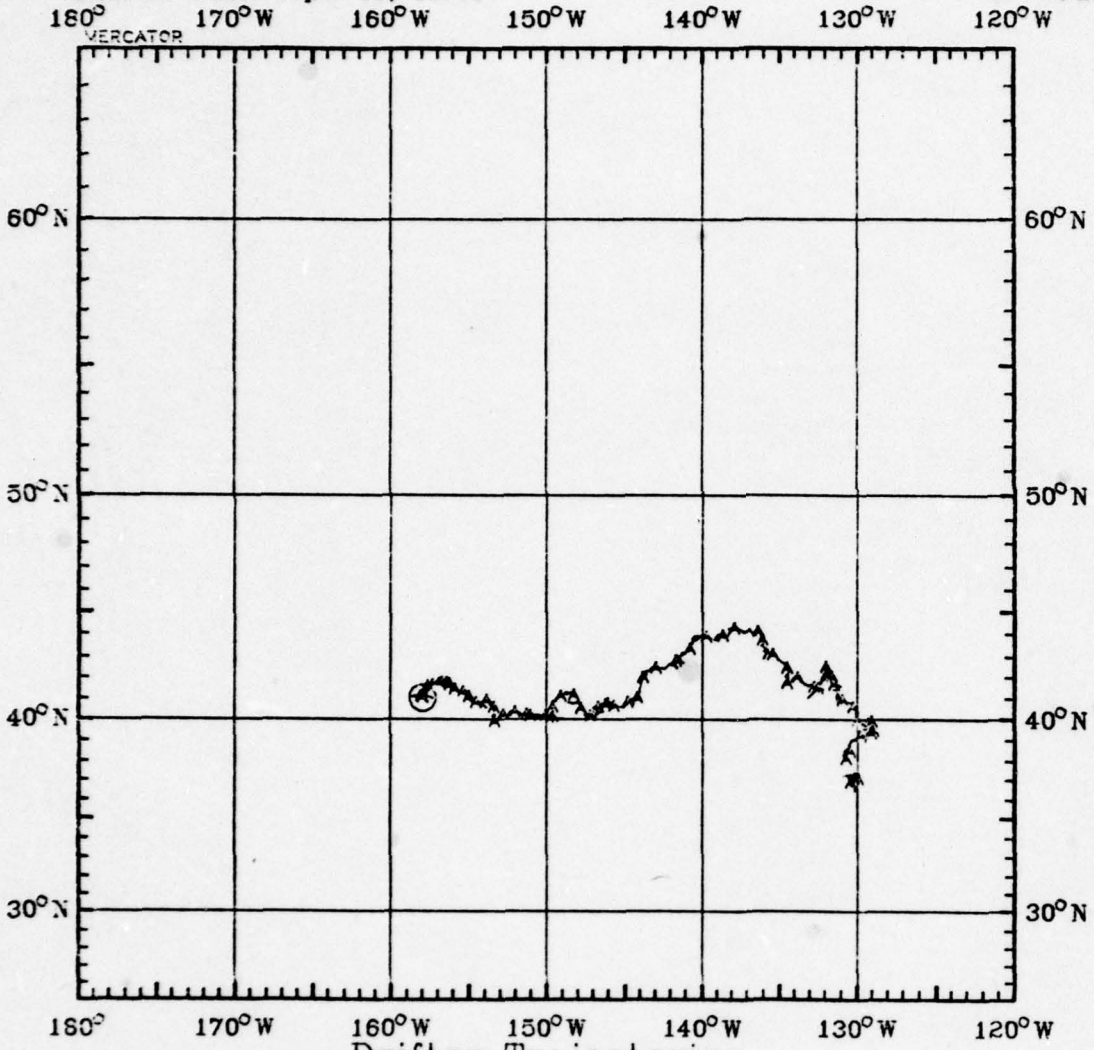
Drifter Id: 0225

Date of Run: Feb. 6, 1978



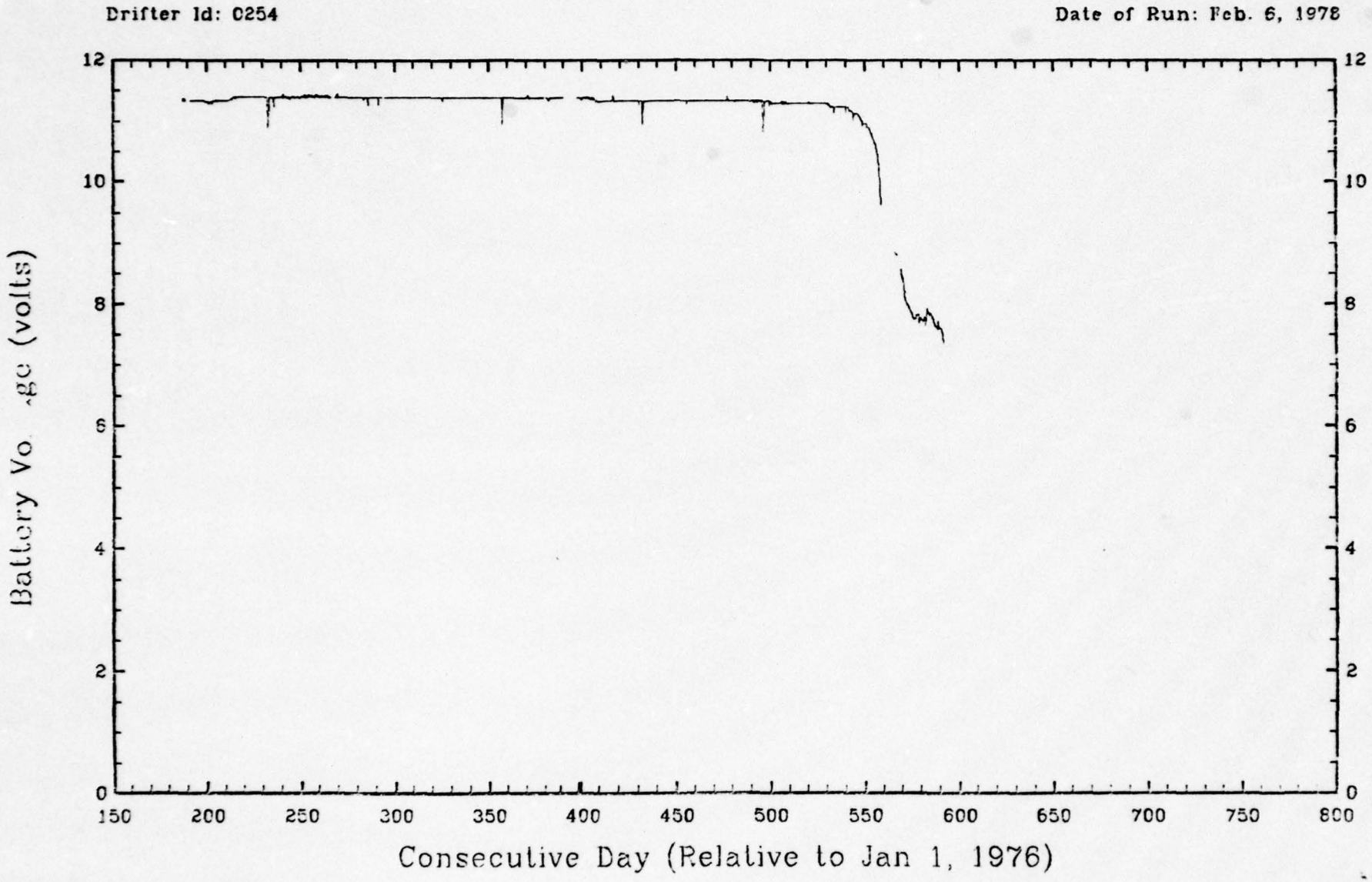
Date of Run: Sept. 15, 1977

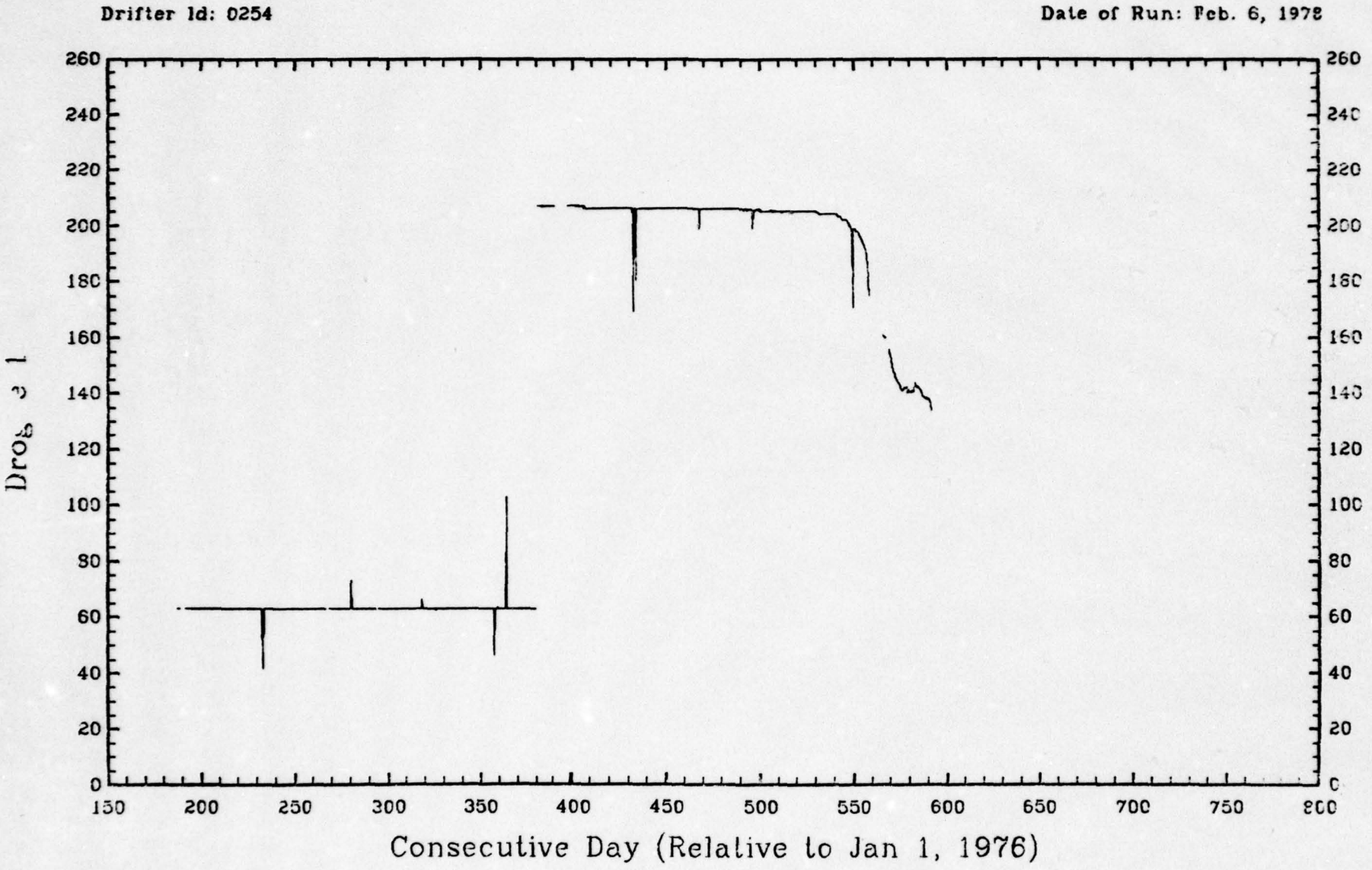
Period Covered:
June 1, 1976 to Sept. 15, 1977

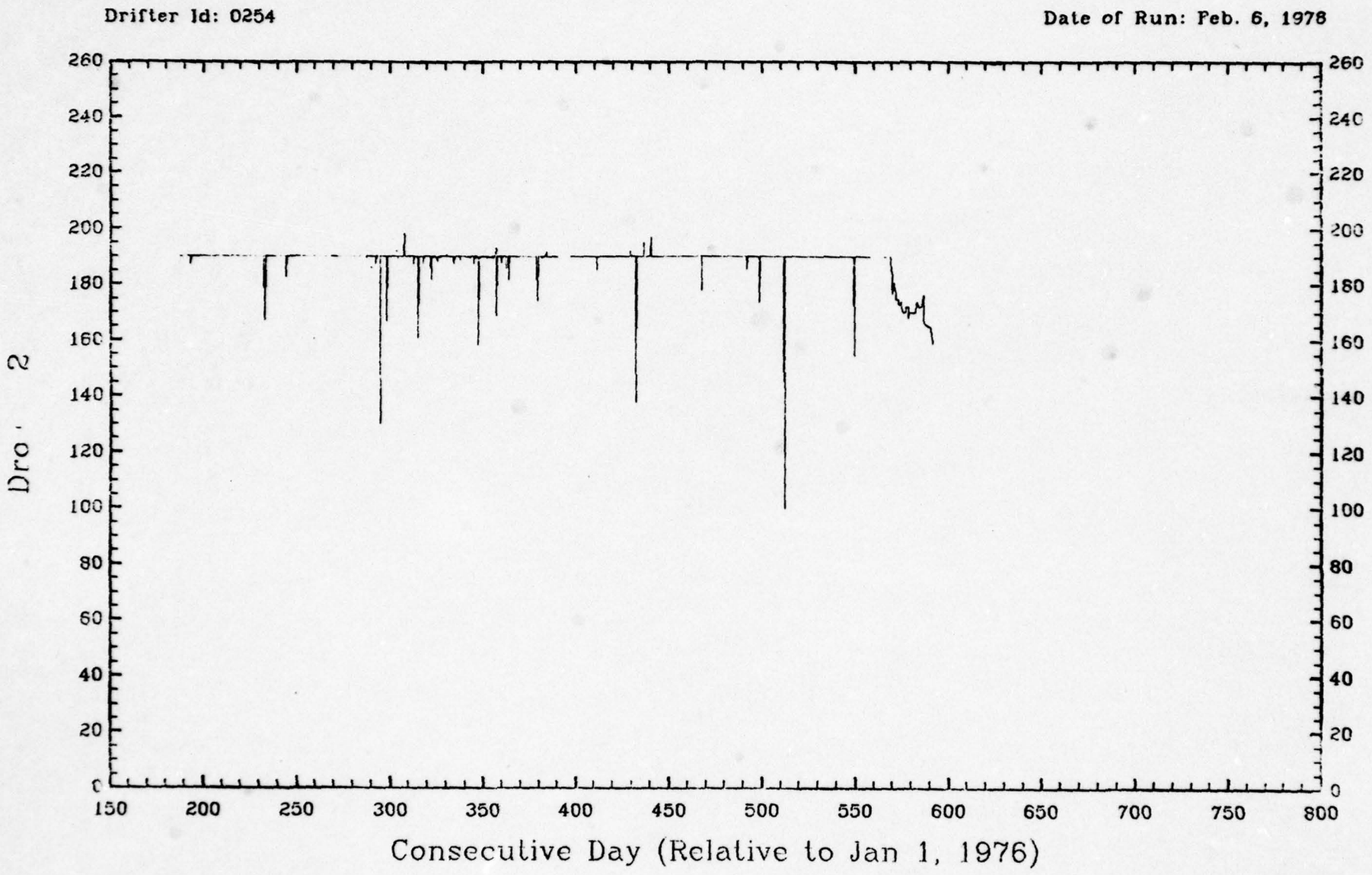


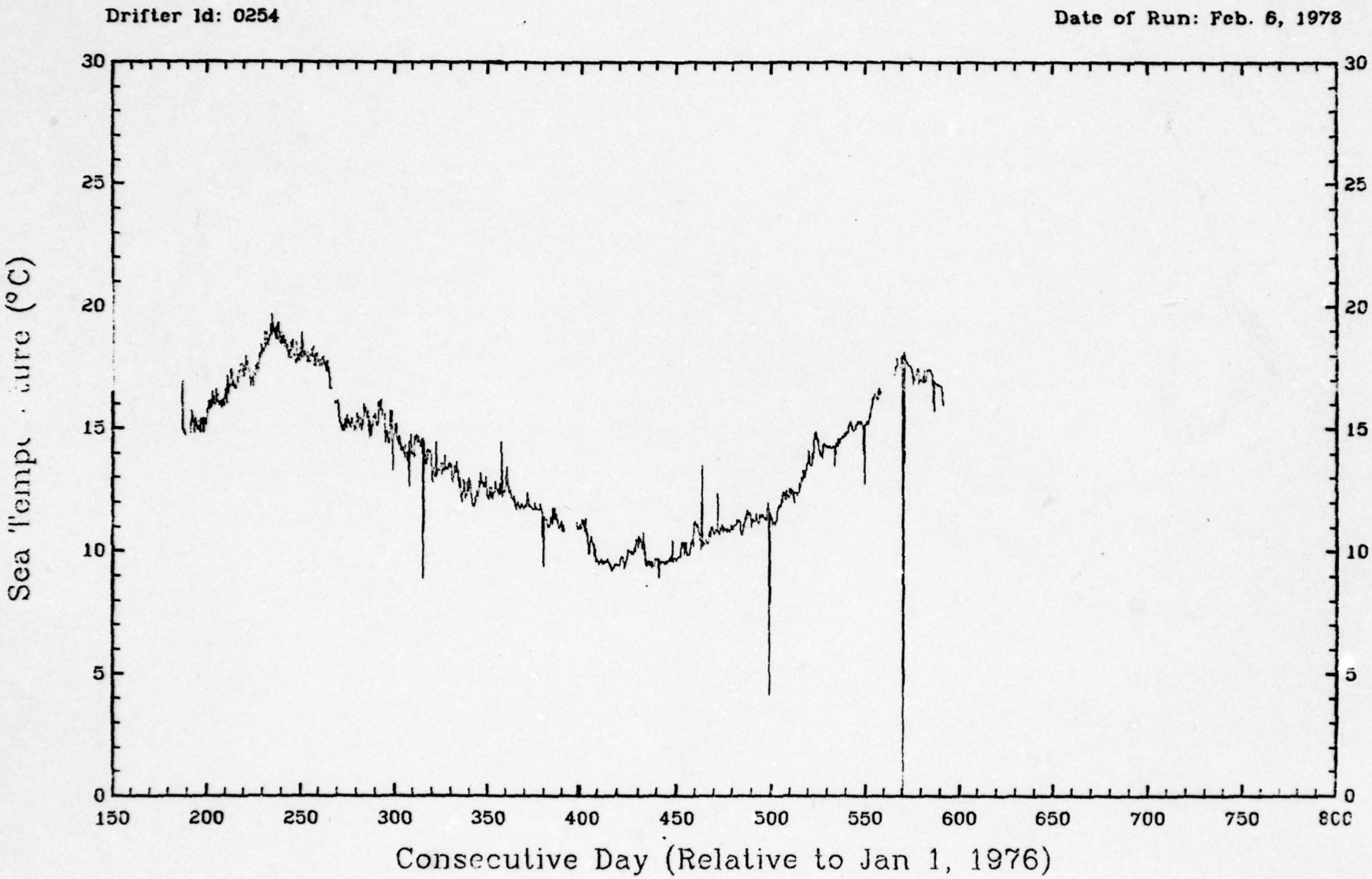
Symbol	Drifter Id
A	0254

Drifter Trajectories
Velocity Checked Positions


Drifter Id: 0254
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

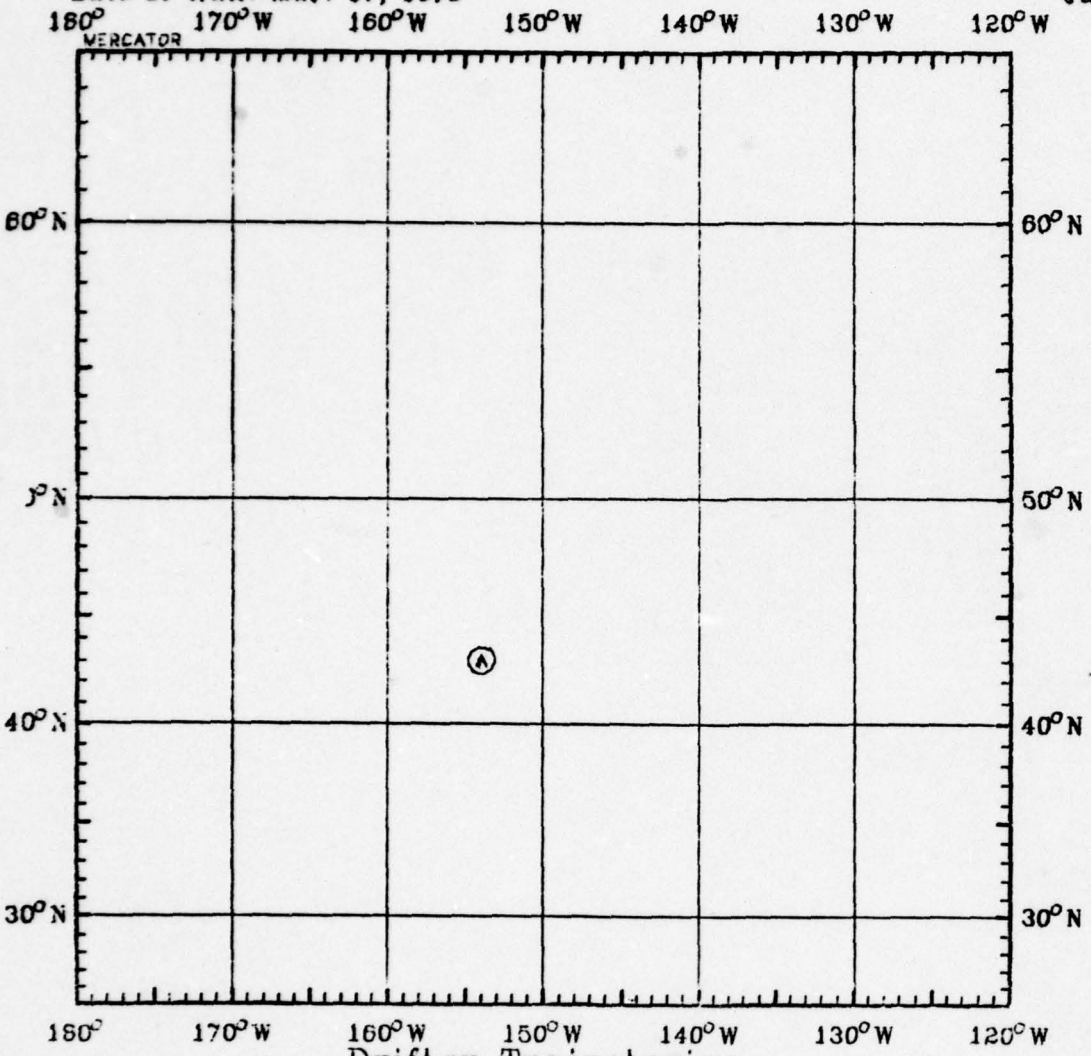

Drifter Id: 0254
Date of Run: Feb. 6, 1978
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0254
Date of Run: Feb. 6, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0254
Date of Run: Feb. 6, 1978
Sea Temperature (°C)
30
25
20
15
10
5
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Date of Run: Mar. 17, 1978

Period Covered:
July 9, 1976 to July 13, 1976



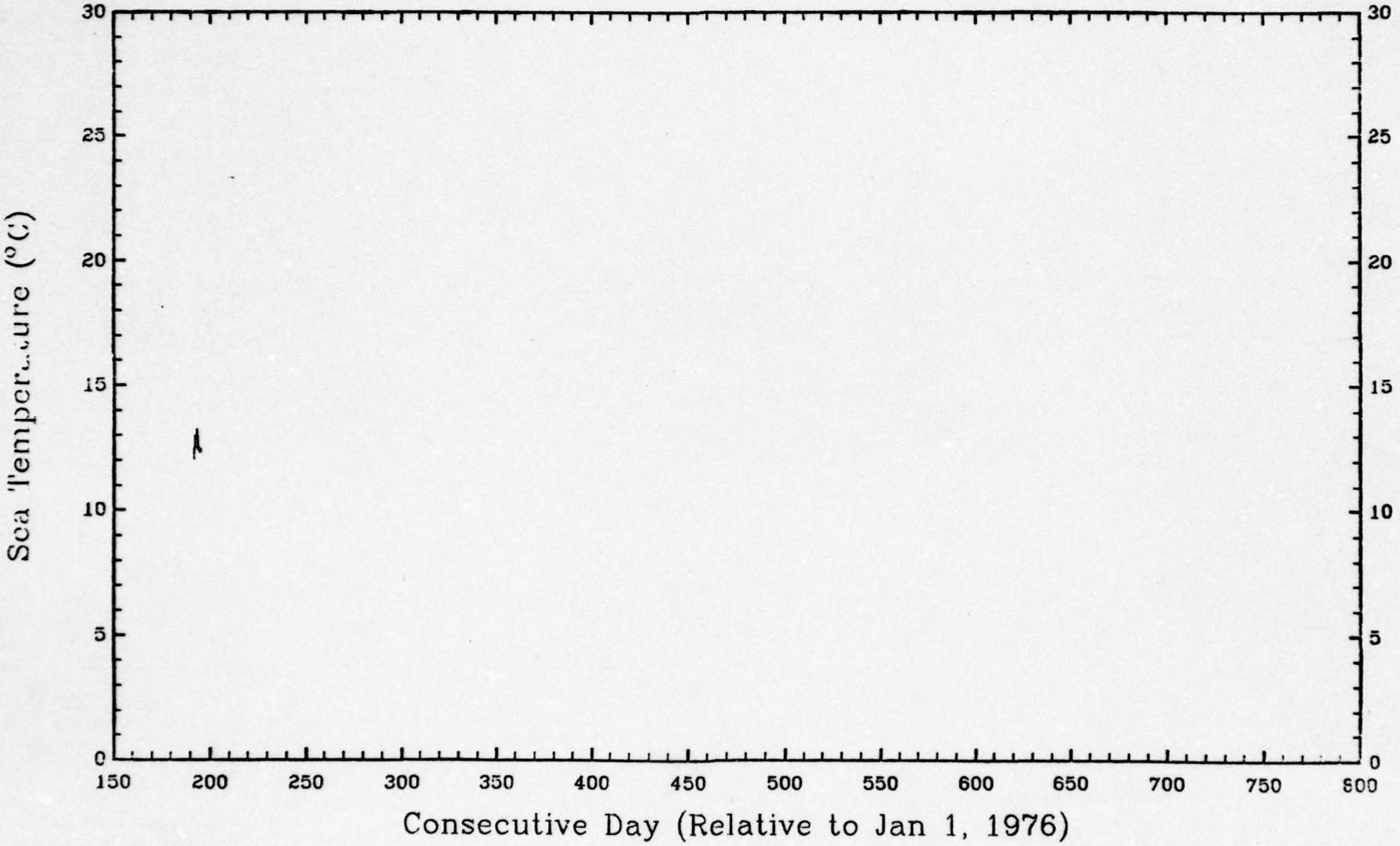
Symbol	Drifter Id
^	0262

Drifter Trajectories

Positions Computed by Interpolation

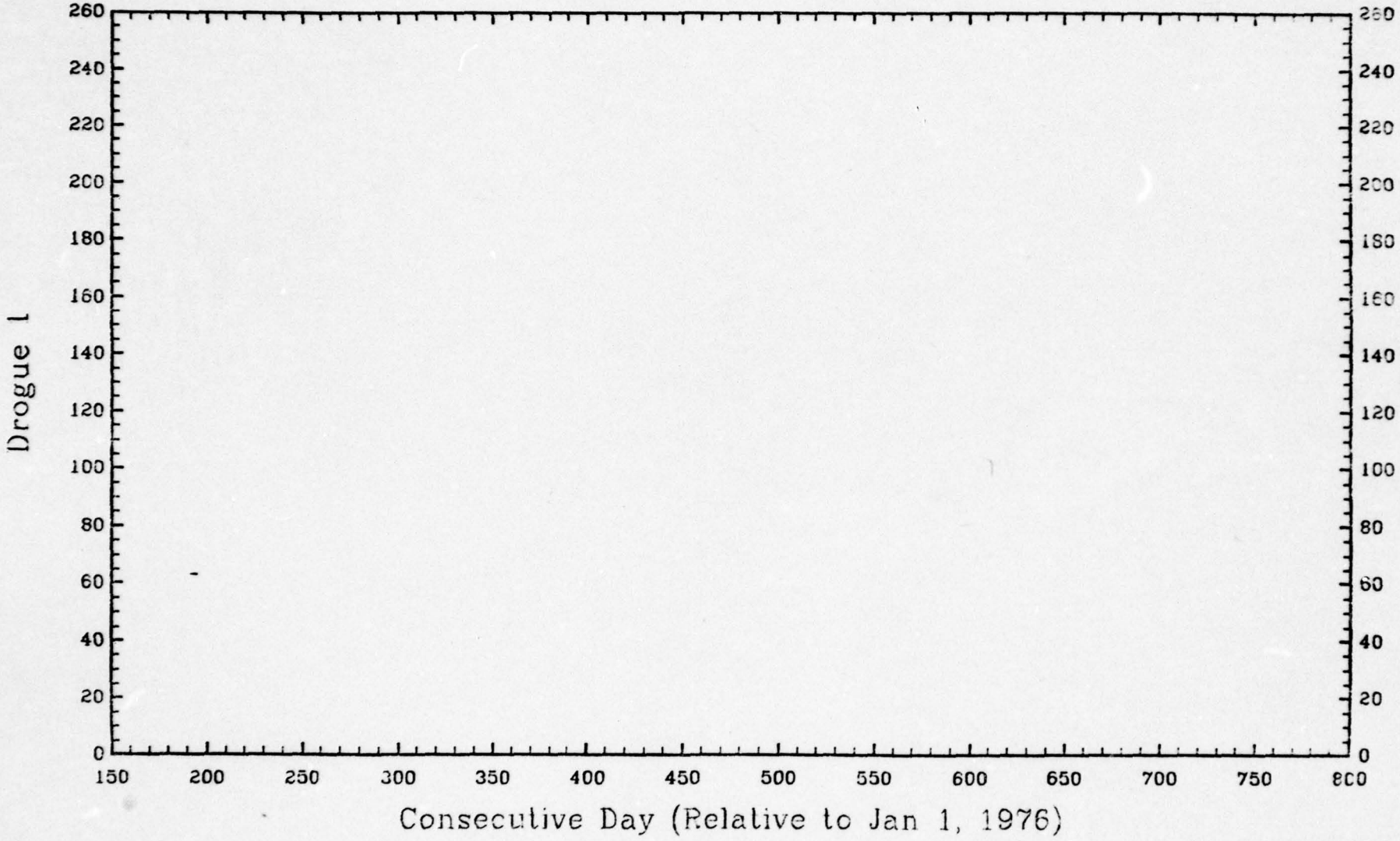
Drifter Id: 0262

Date of Run: Feb. 6, 1978



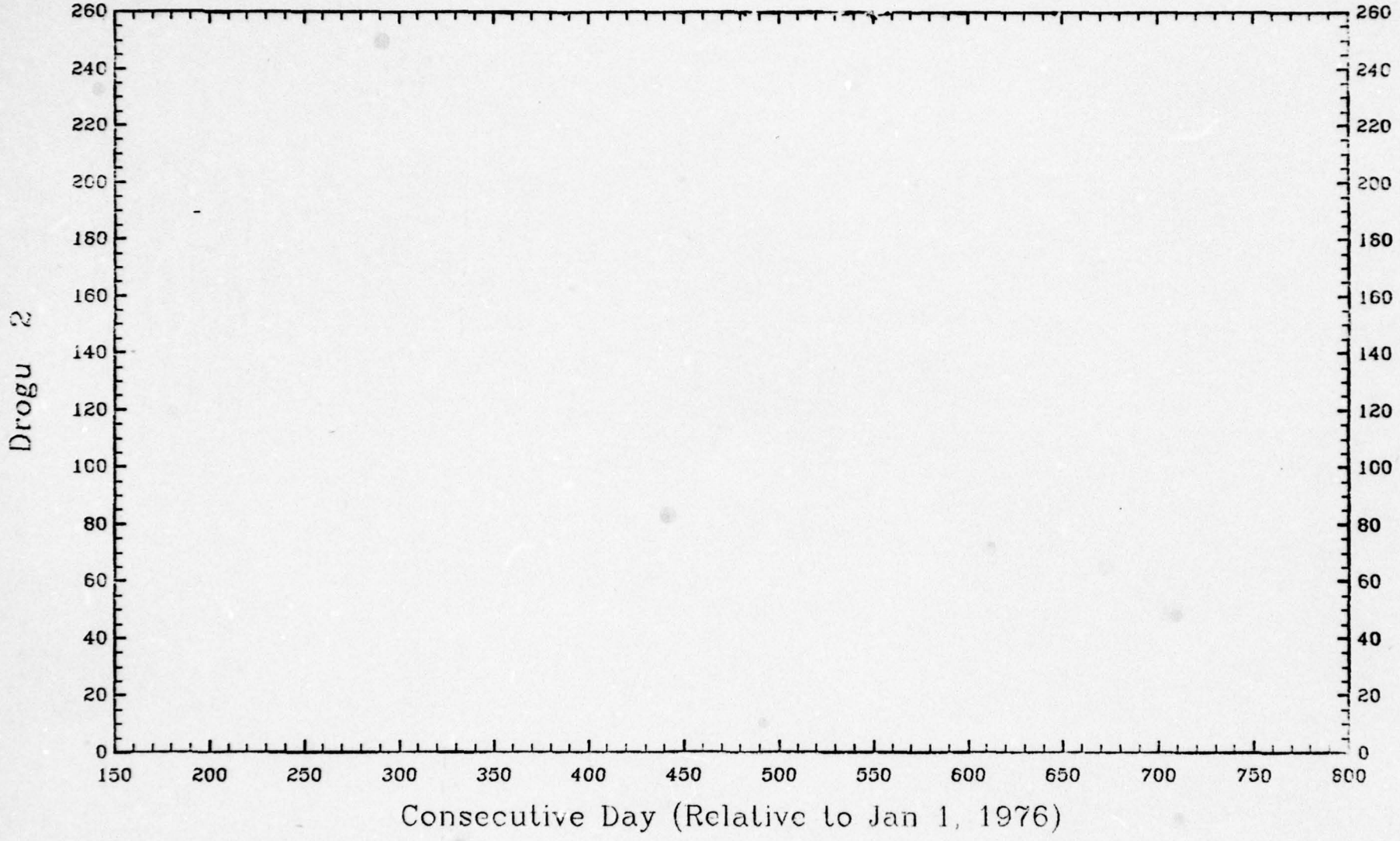
Drifter Id: 0262

Date of Run: Feb. 6, 1978



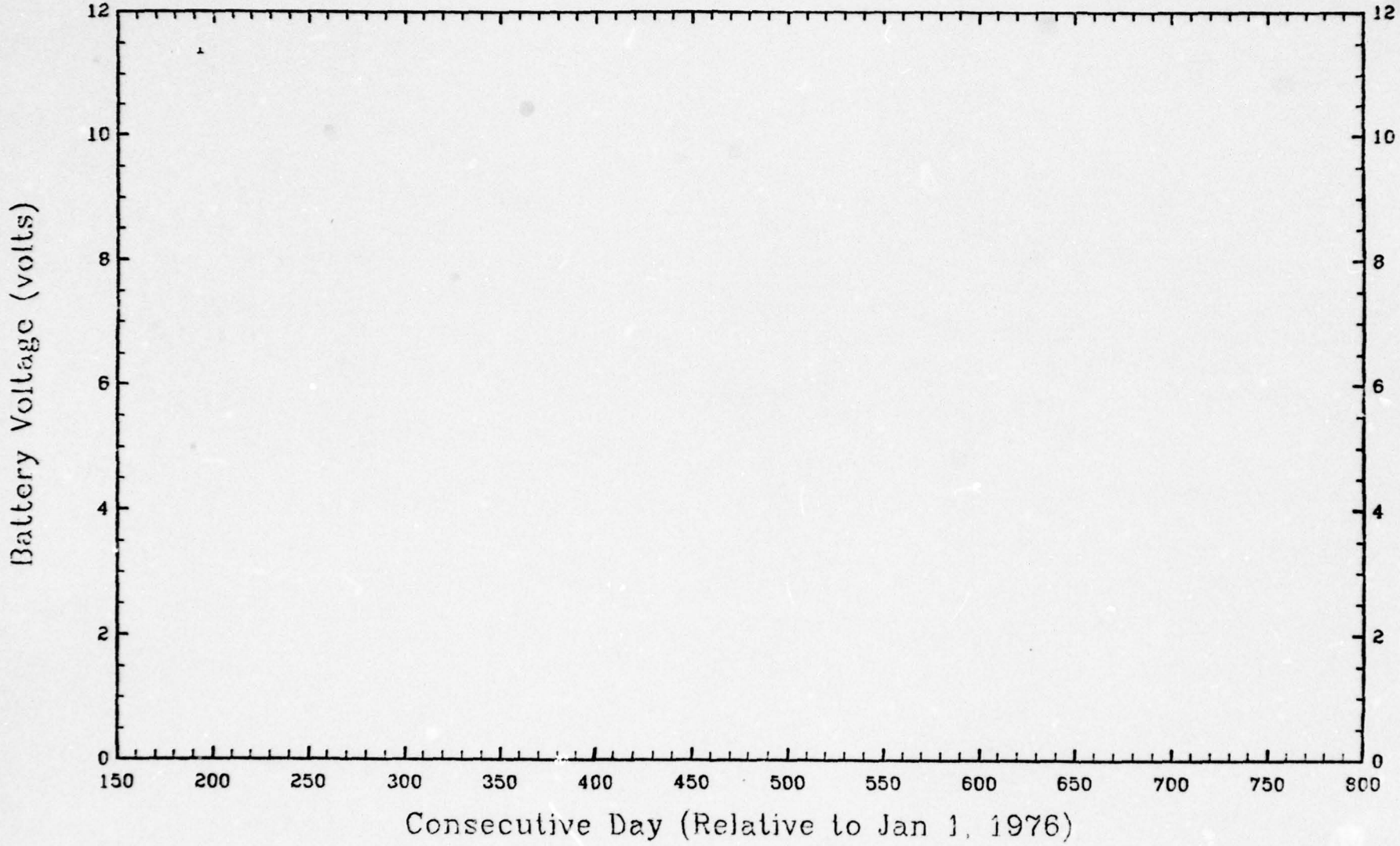
Drifter Id: 0262

Date of Run: Feb. 6, 1978



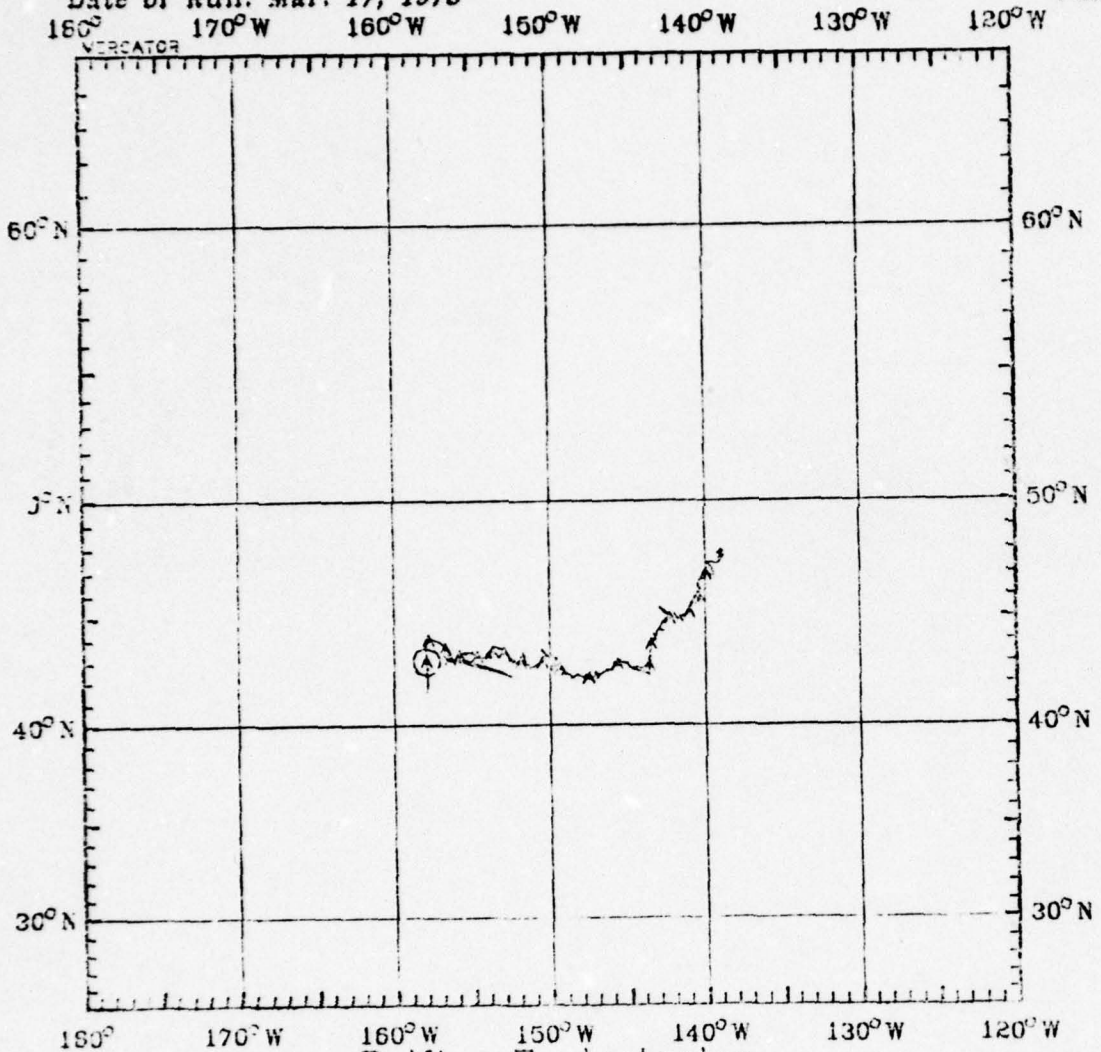
Drifter Id: 0262

Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1978

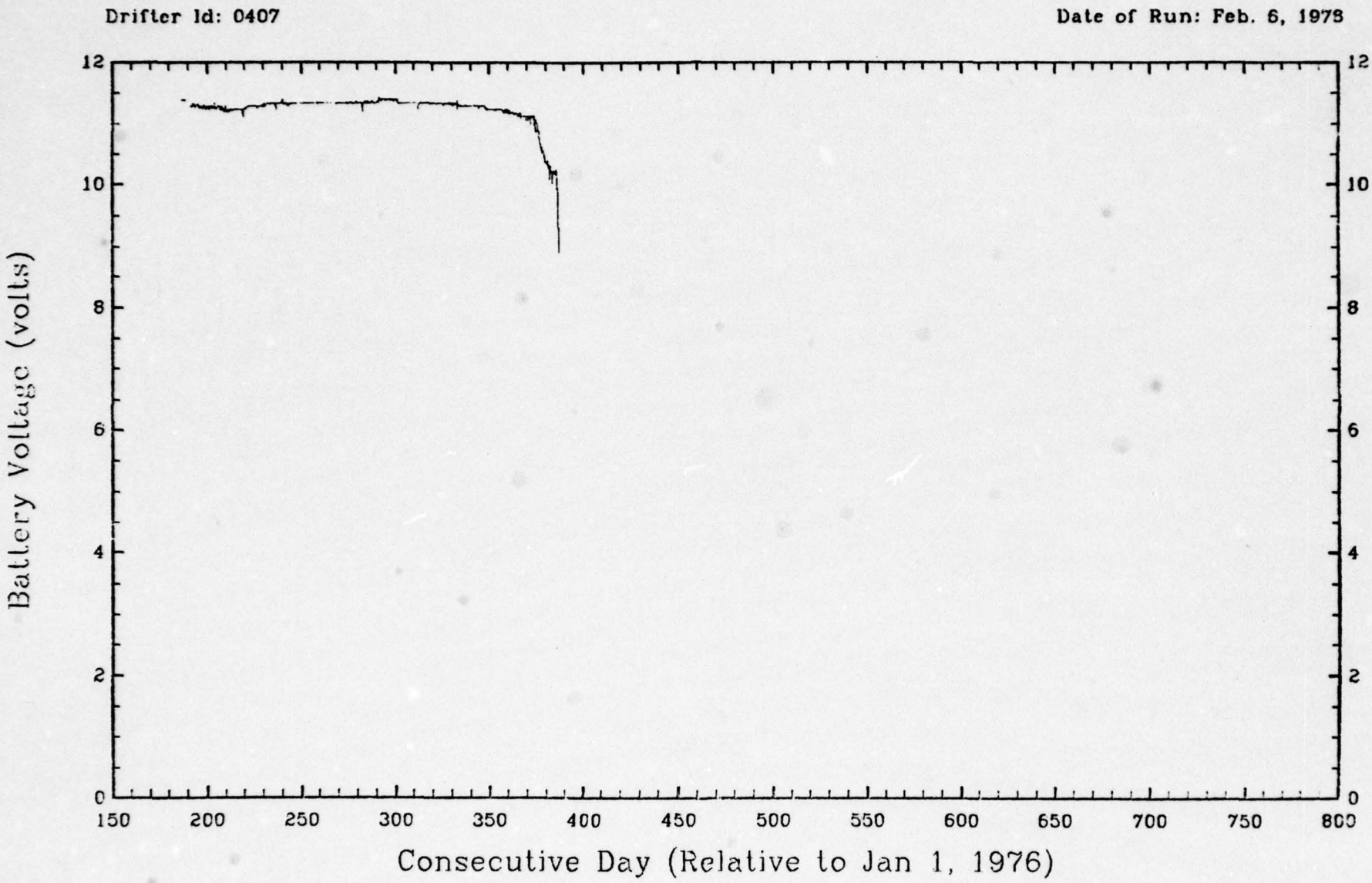
Period Covered:
June 1, 1976 to Mar. 17, 1978

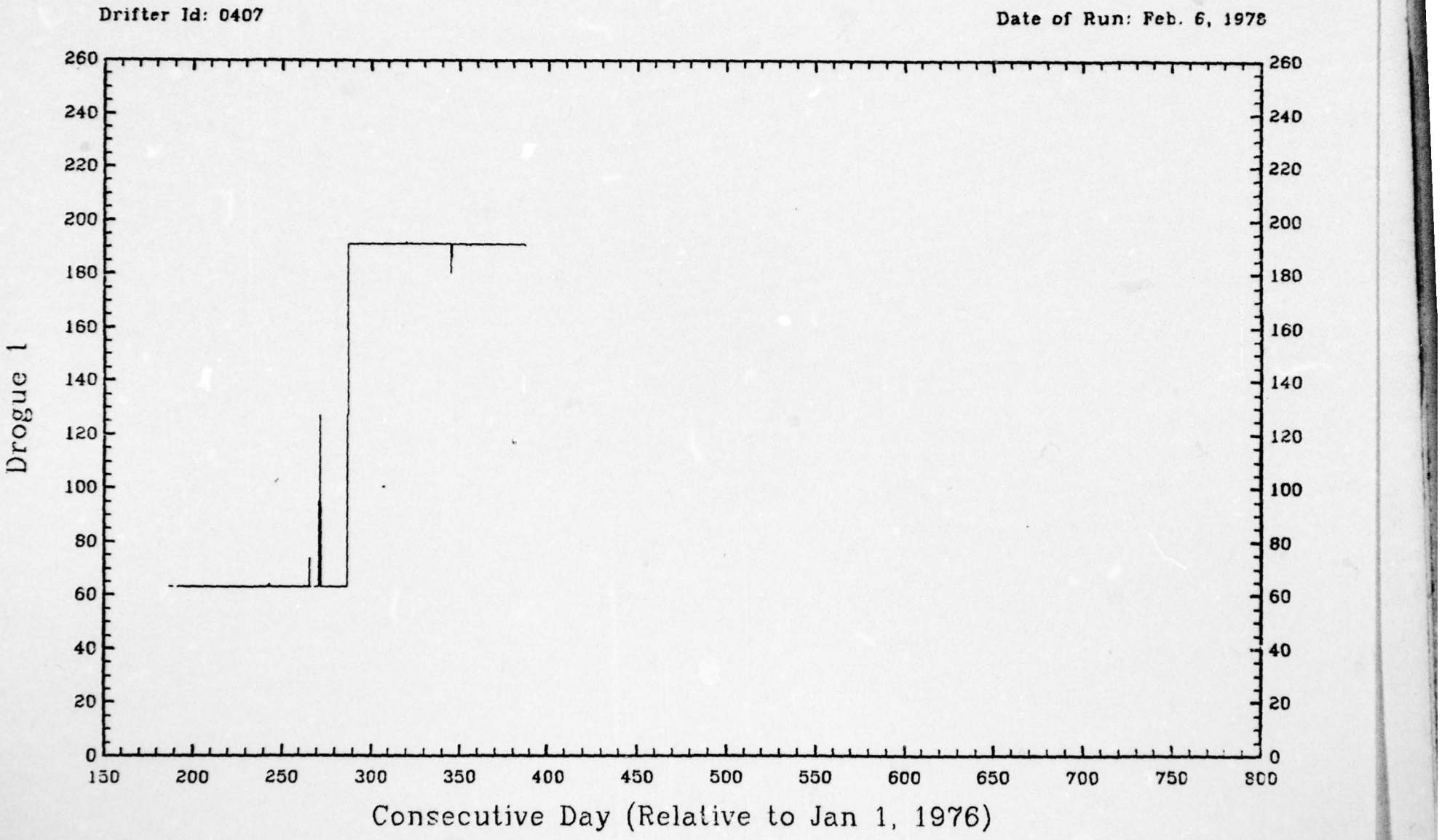


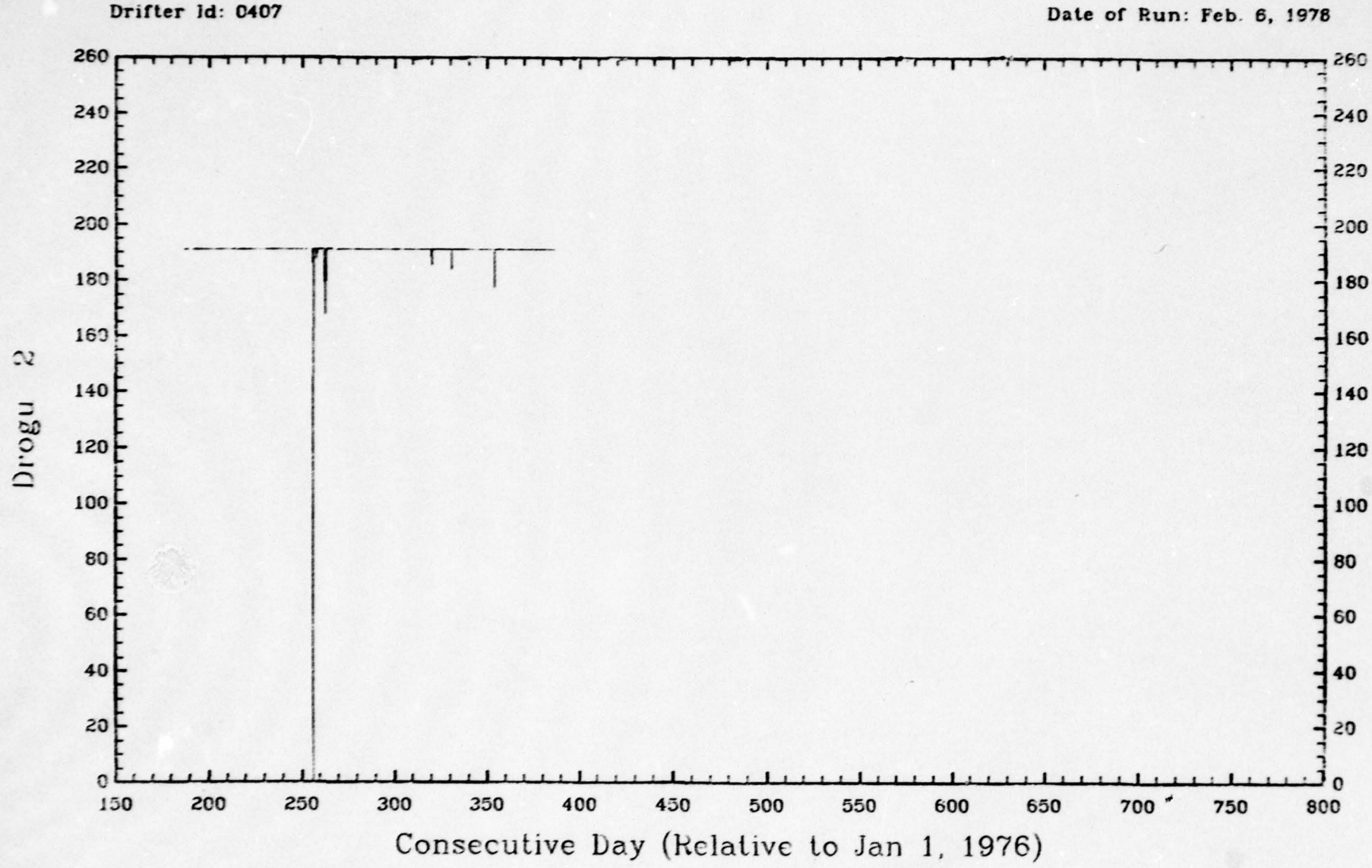
Symbol	Drifter Id
^	0407

Drifter Trajectories

Positions Computed by Interpolation

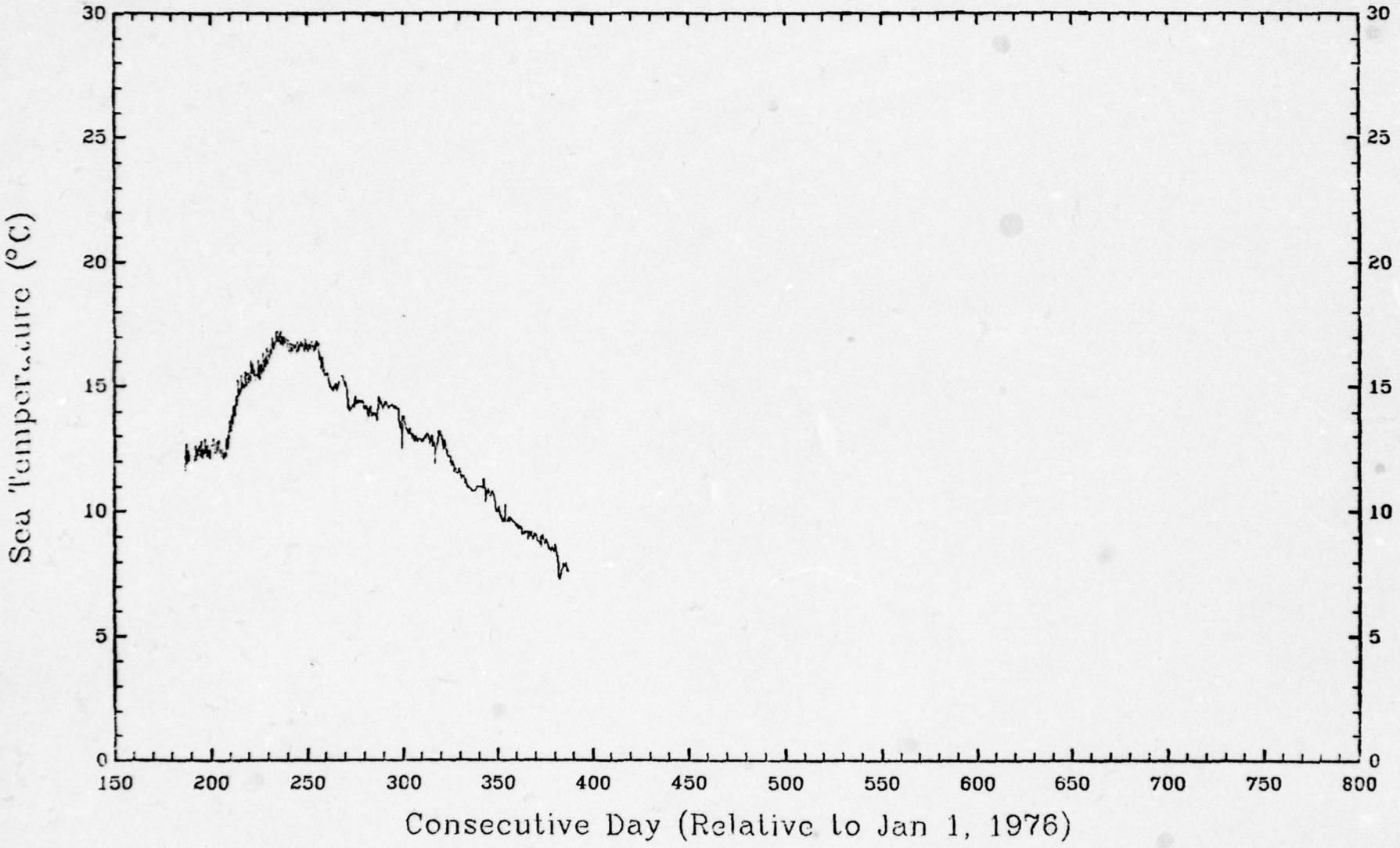

Drifter Id: 0407
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
12
10
8
6
4
2
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0407
Date of Run: Feb. 6, 1978
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 0407
Date of Run: Feb. 6, 1978
Drogu 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

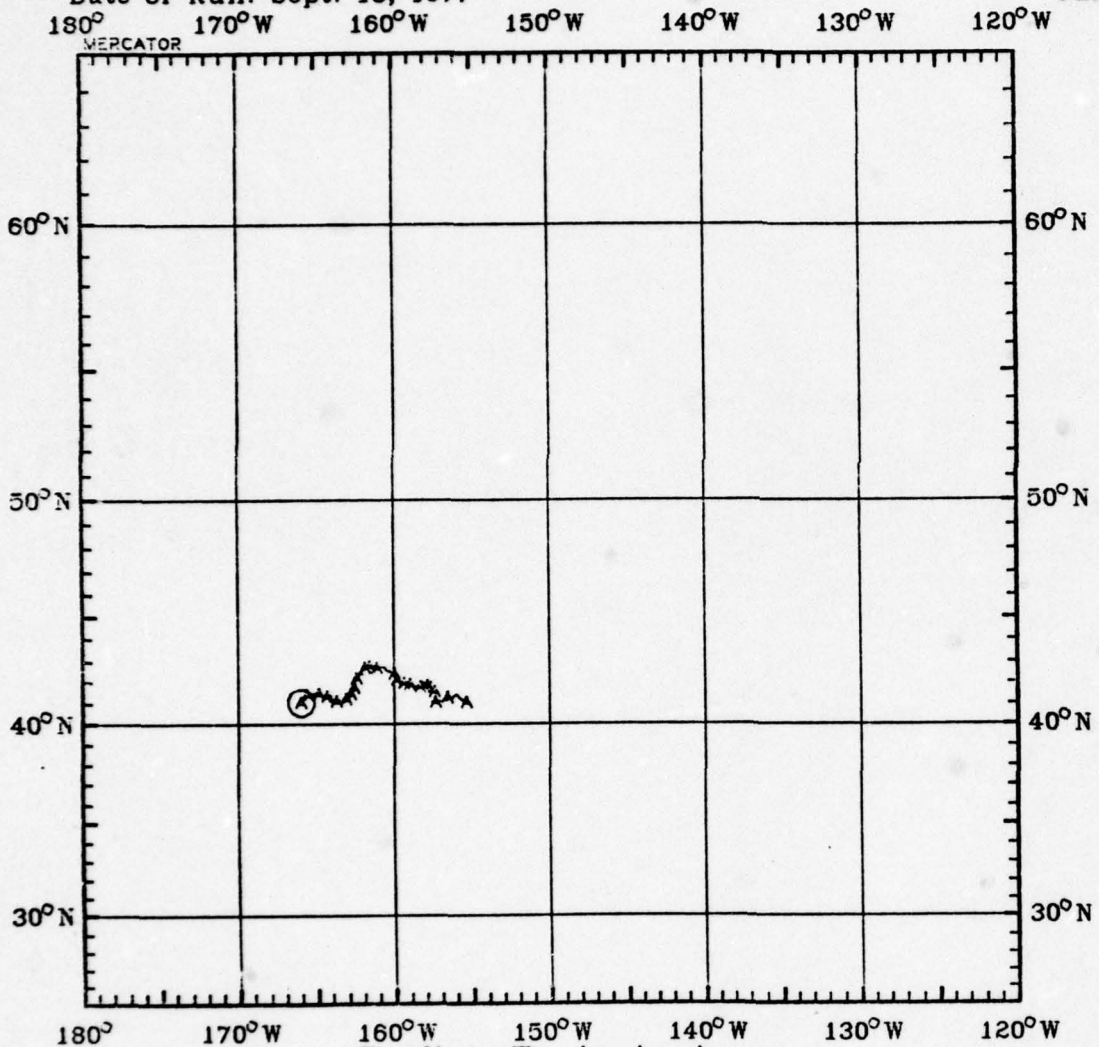
Drifter Id: 0407

Date of Run: Feb. 6, 1978



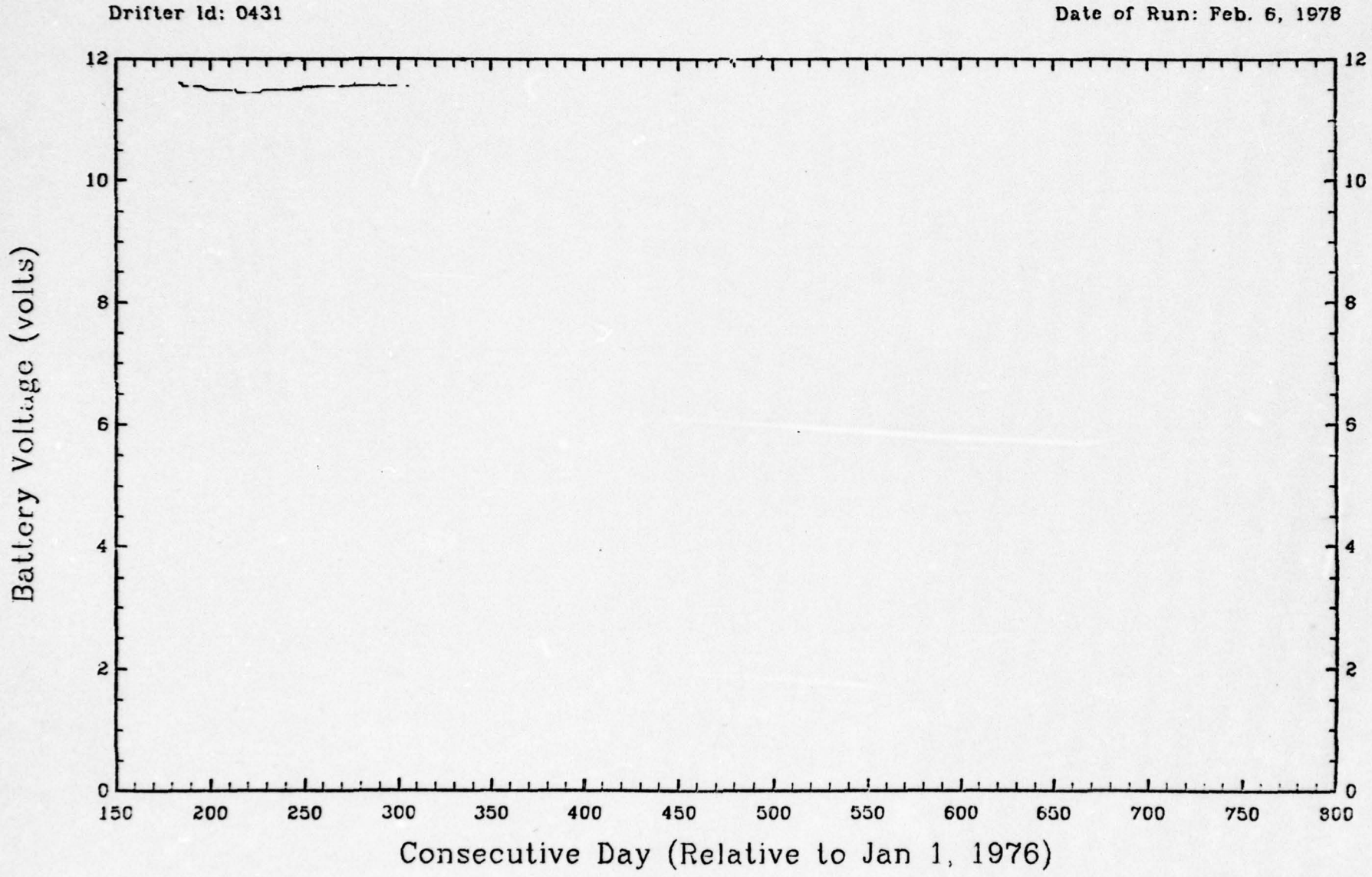
Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977



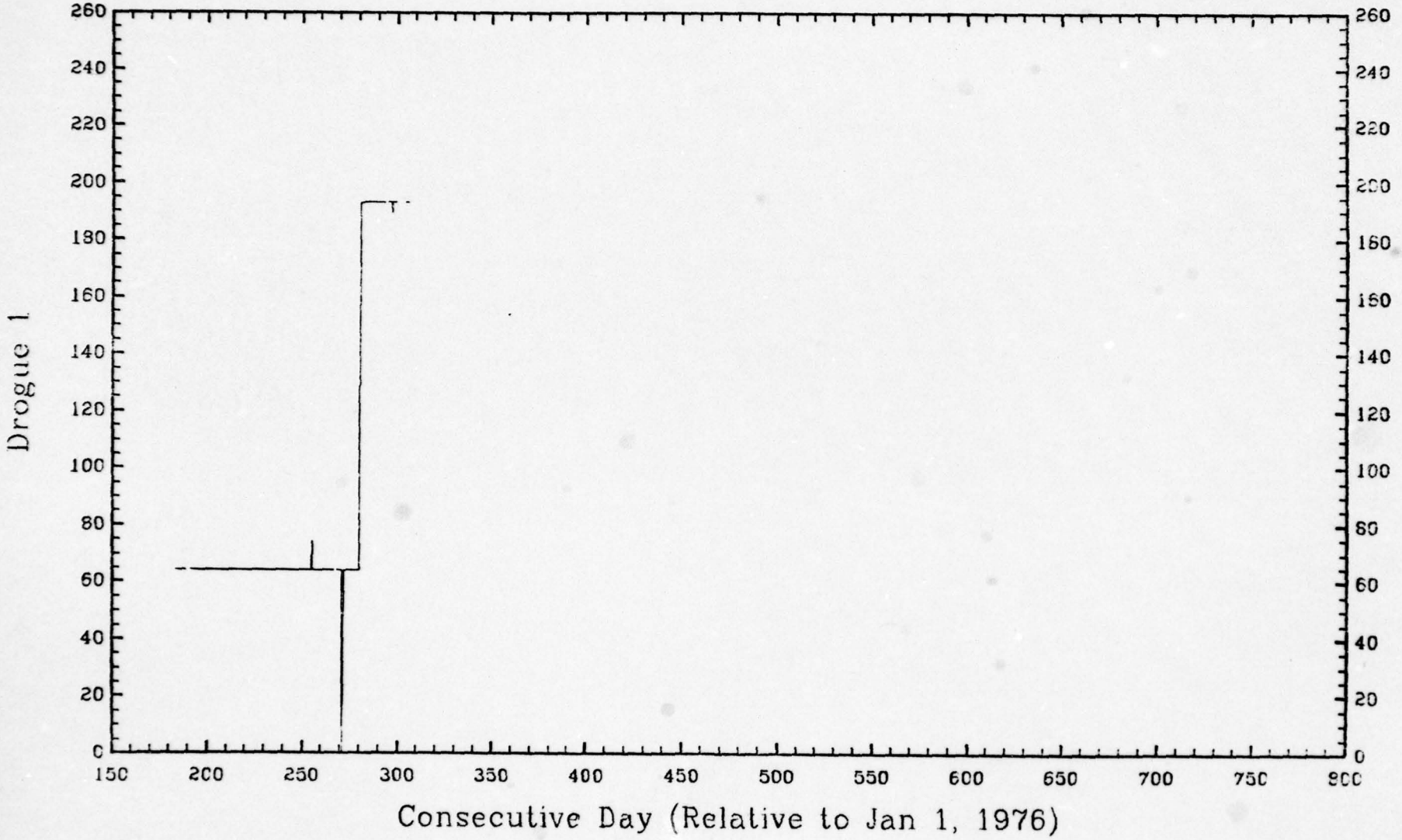
Symbol	Drifter Id
A	0431

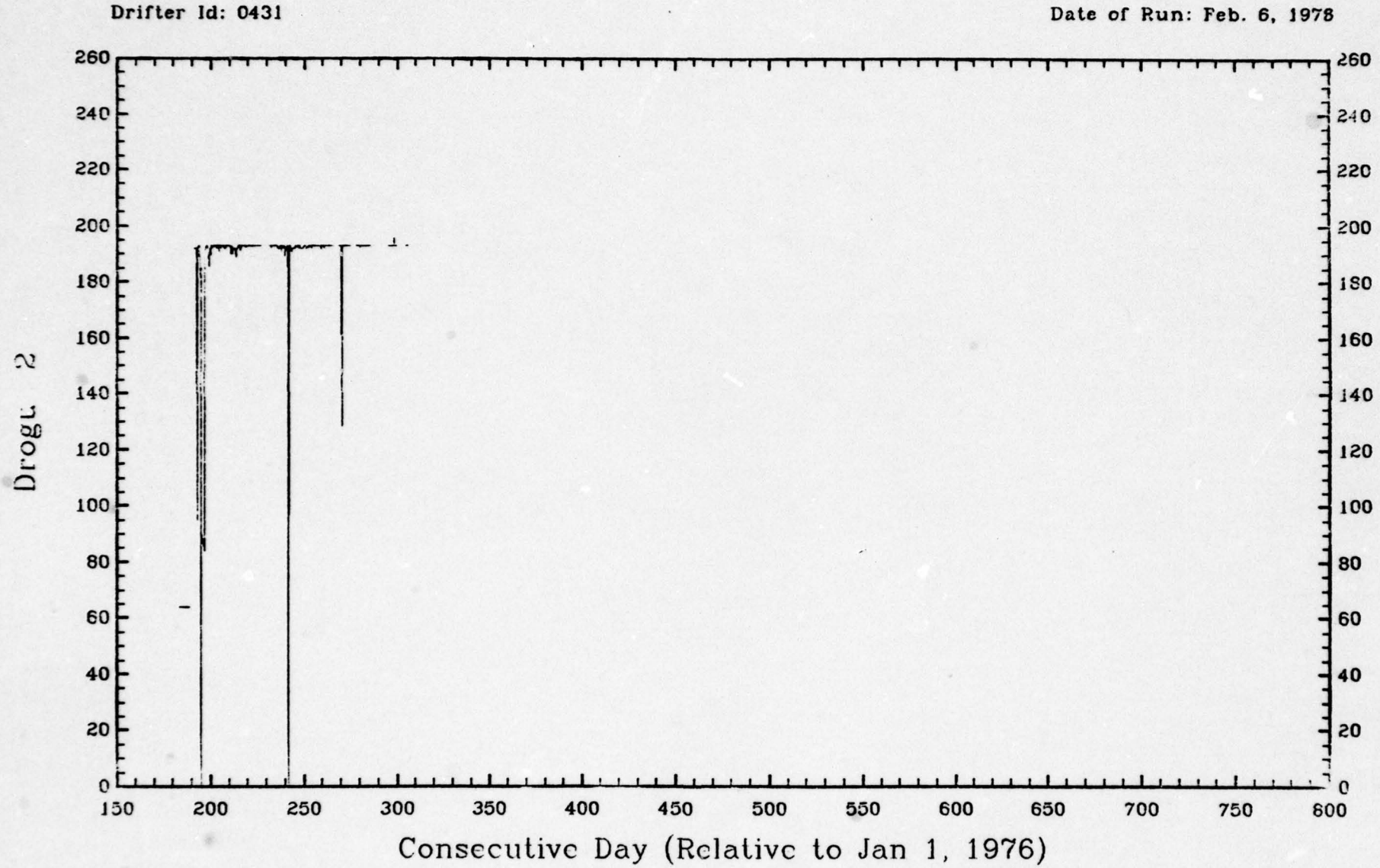
Drifter Trajectories
Velocity Checked Positions


Drifter Id: 0431
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
12
10
8
6
4
2
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0431

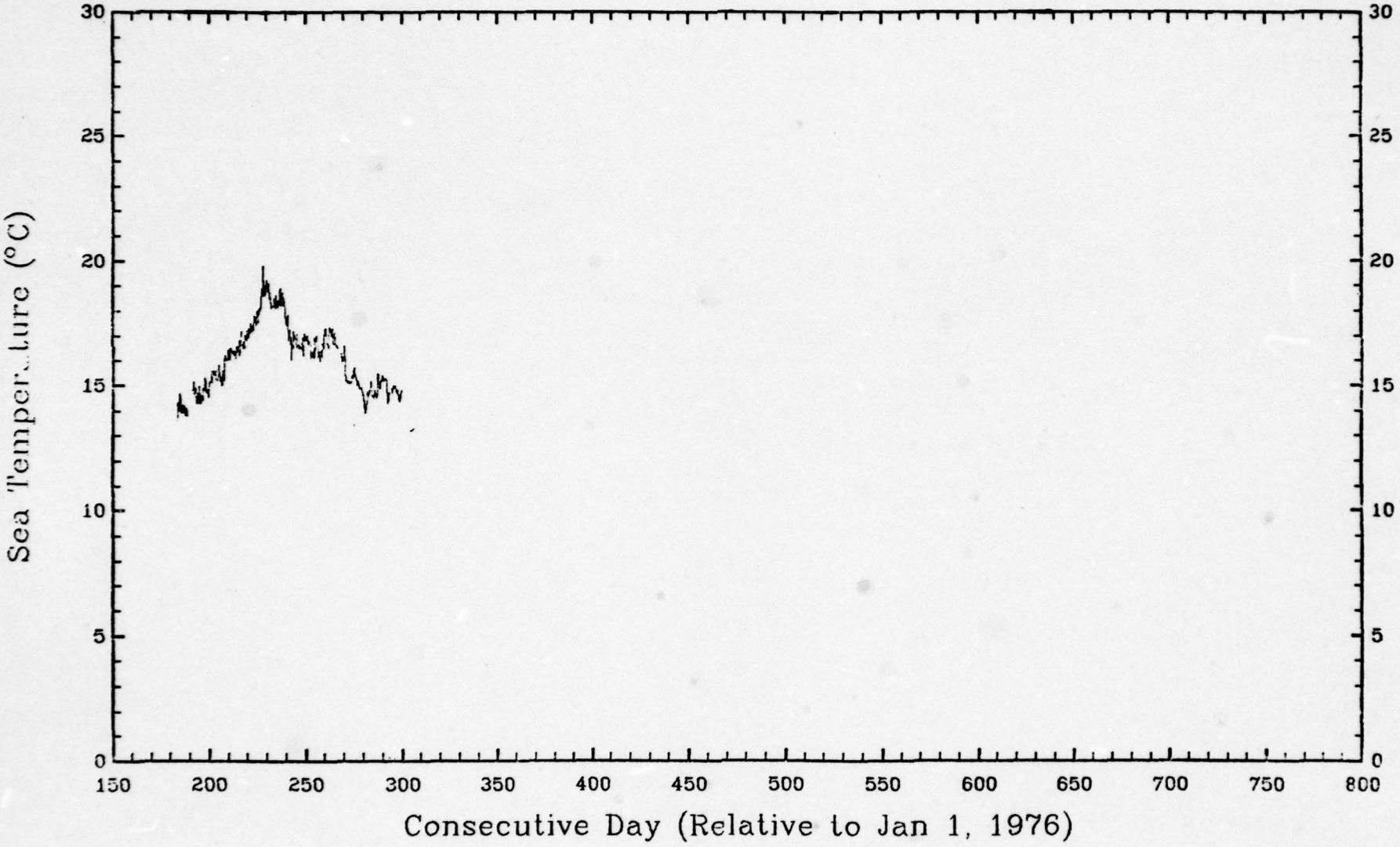
Date of Run: Feb. 6, 1978




Drifter Id: 0431
Date of Run: Feb. 6, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0431

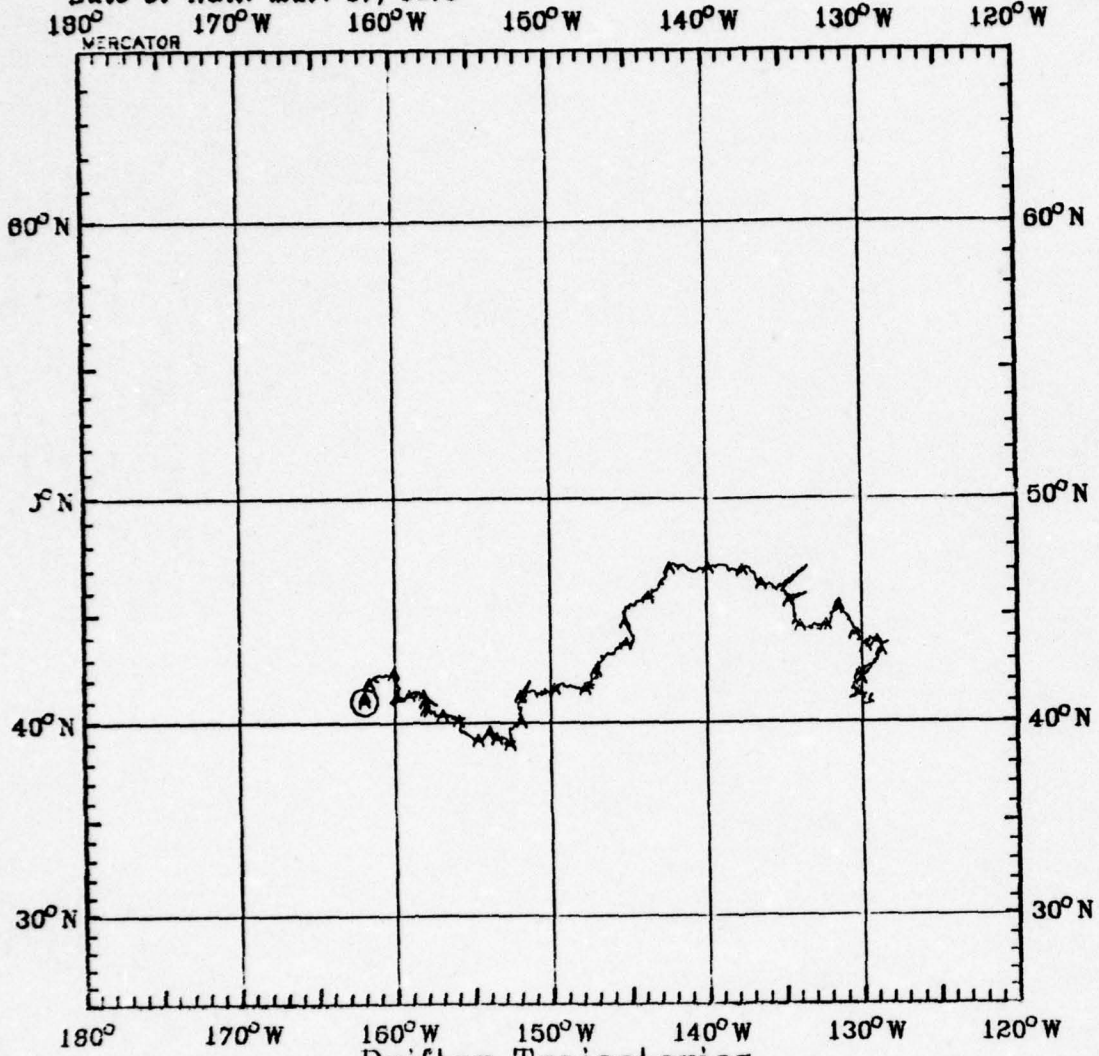
Date of Run: Feb. 6, 1978



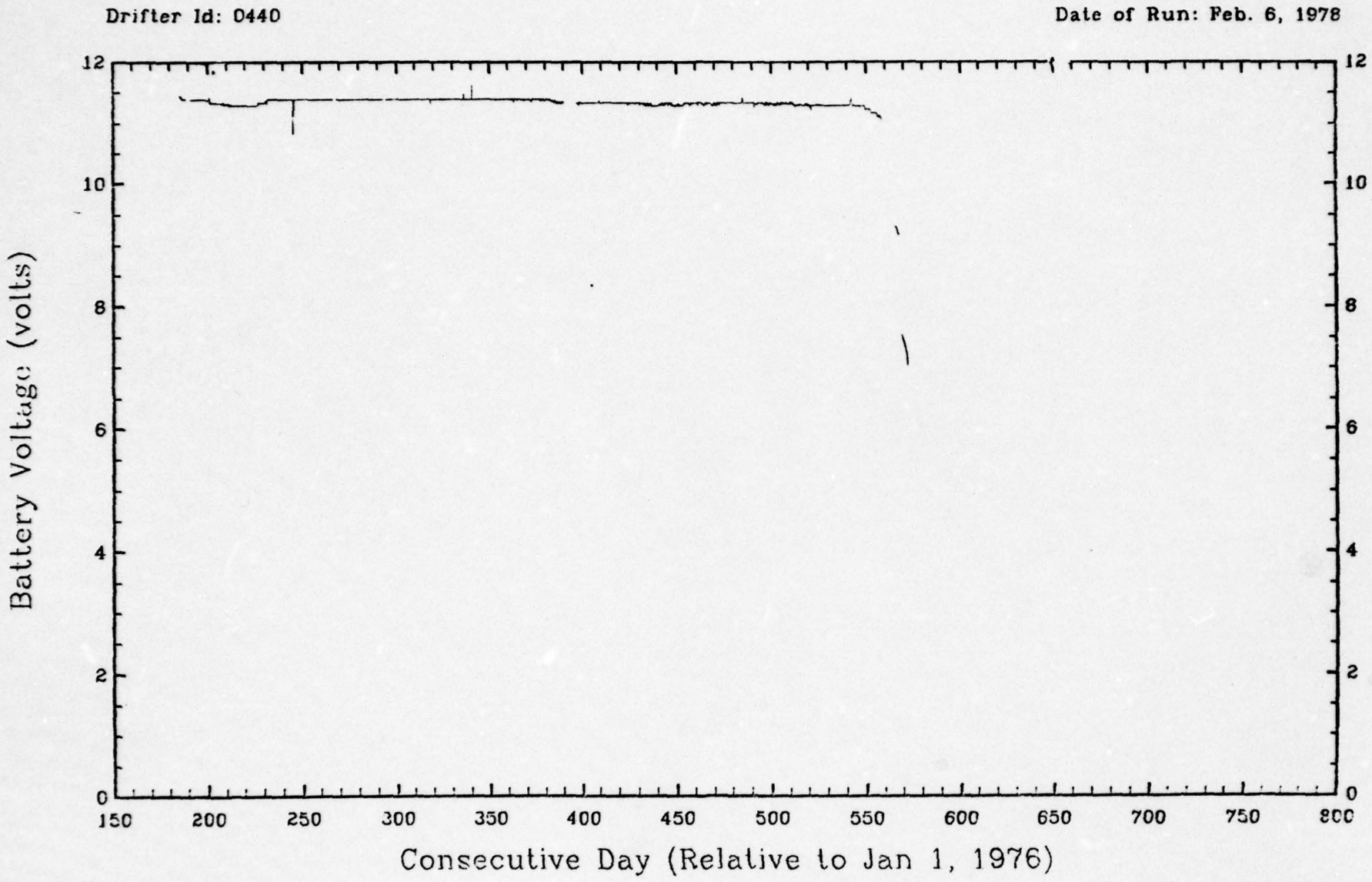
Date of Run: Mar. 17, 1978

Period Covered:
June 1, 1976 to Mar. 17, 1976

Symbol	Drifter Id
A	0440

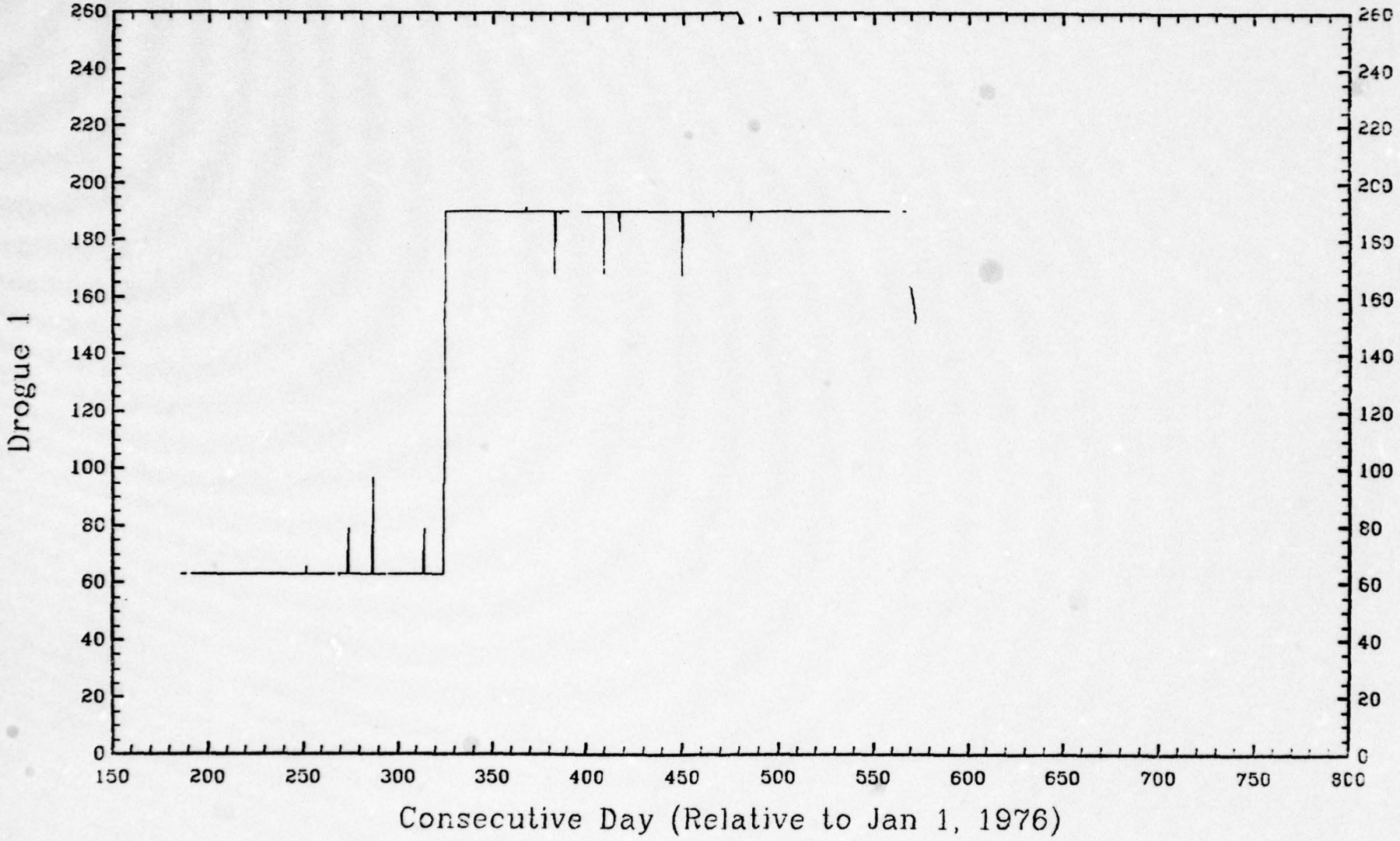


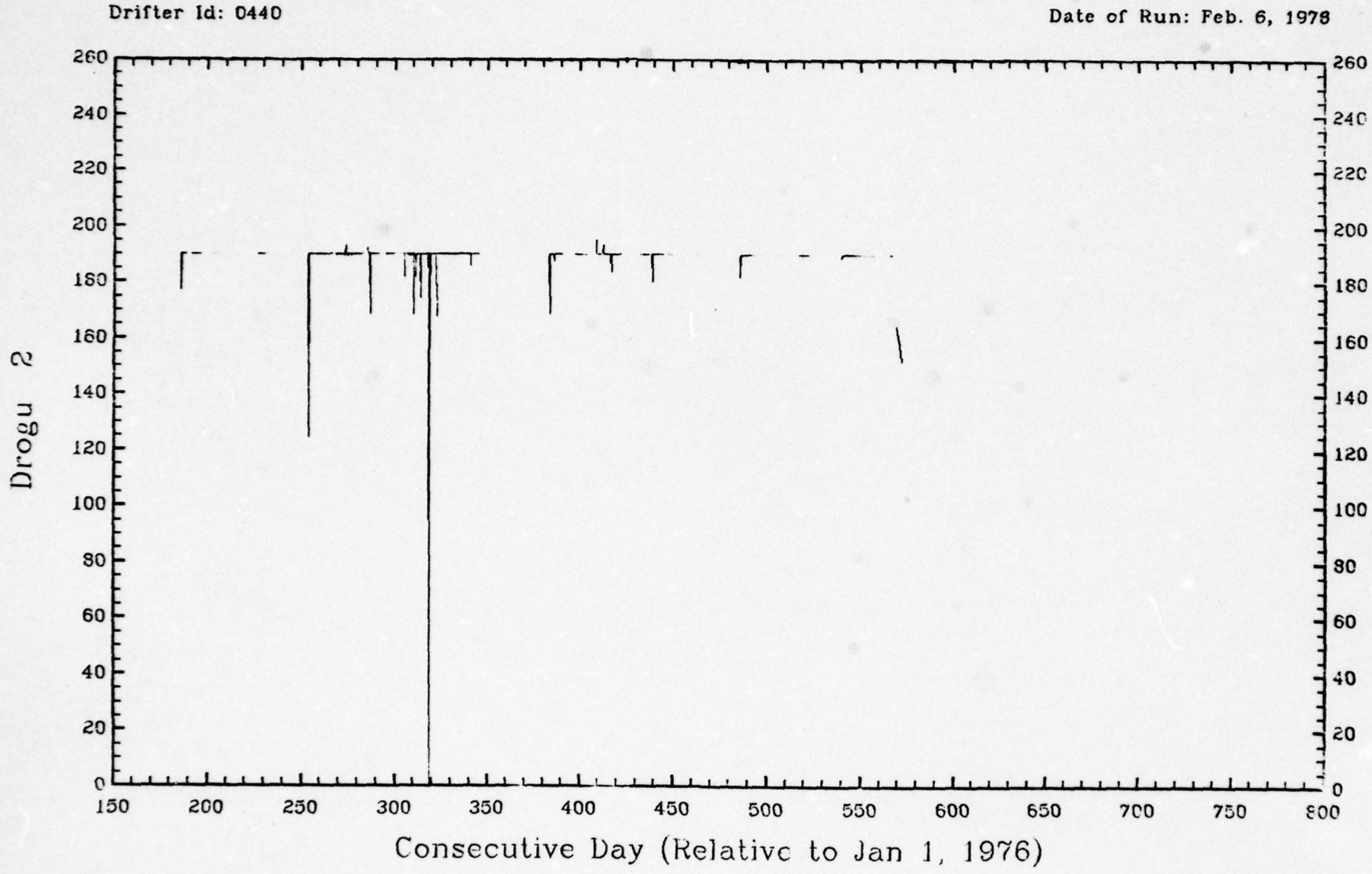
Drifter Trajectories
Positions Computed by Interpolation


Drifter Id: 0440
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
12
10
8
6
4
2
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 0440

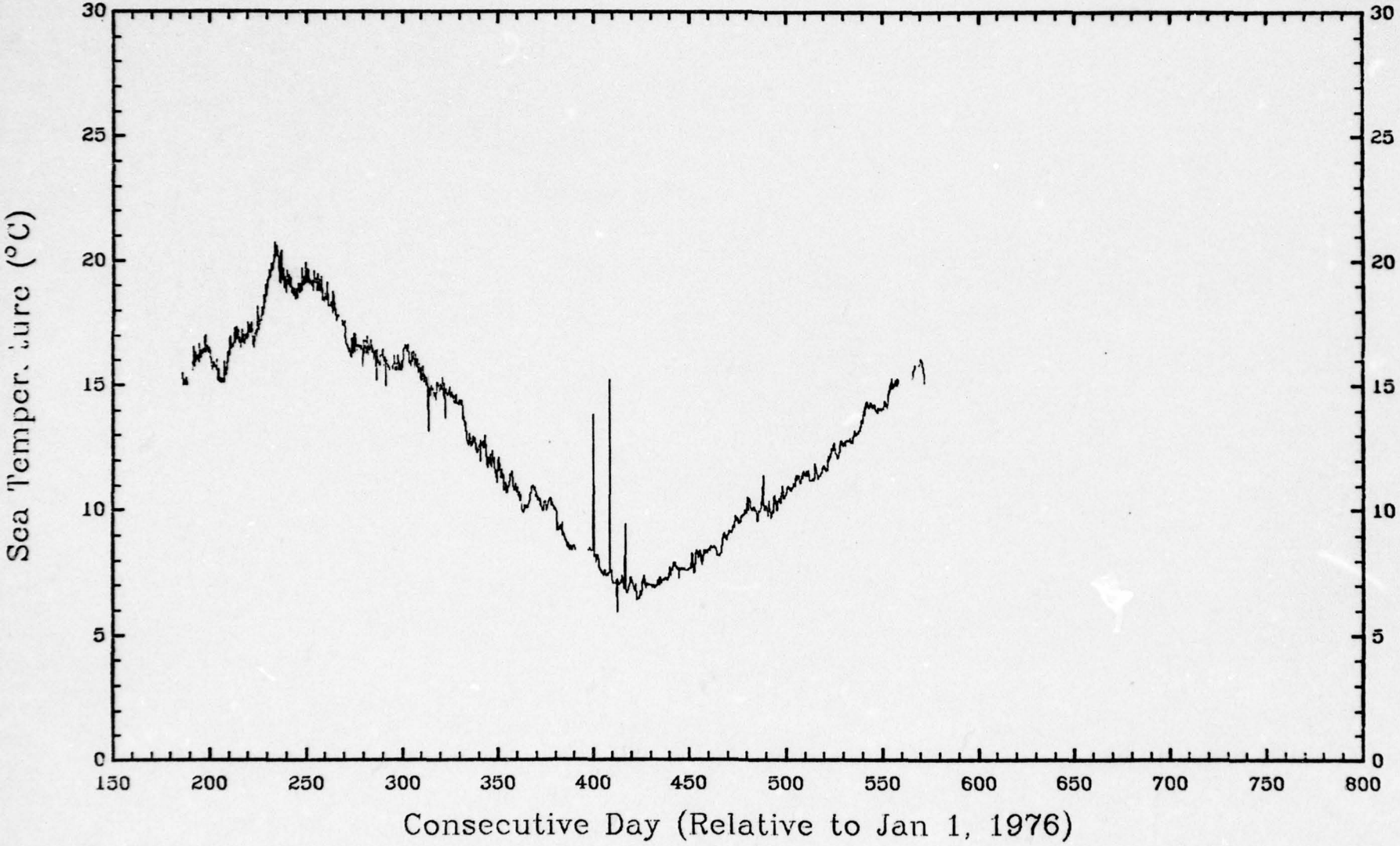
Date of Run: Feb. 6, 1978




Drifter Id: 0440
Date of Run: Feb. 6, 1978
Drogu 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relativc to Jan 1, 1976)

Drifter Id: 0440

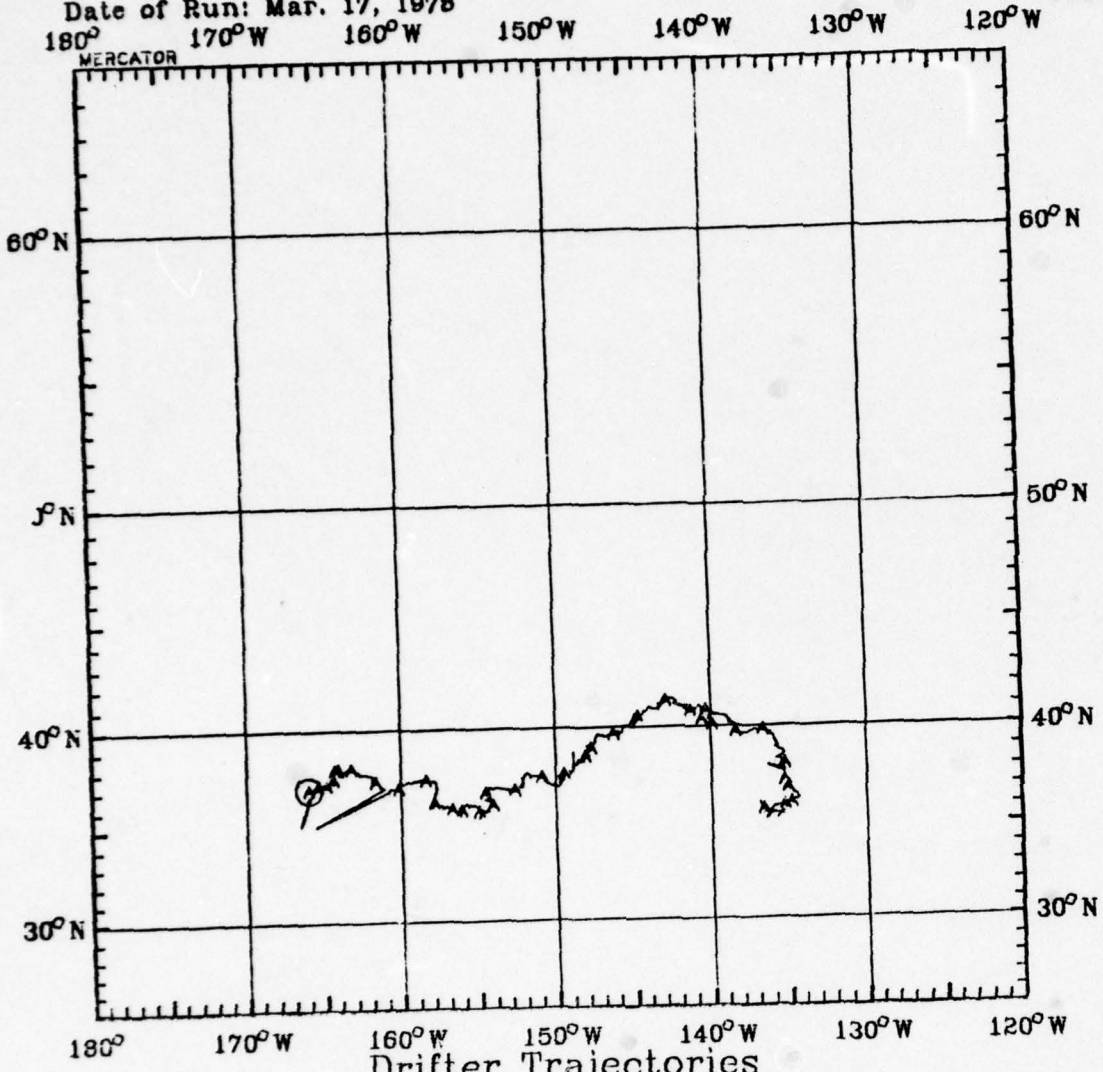
Date of Run: Feb. 6, 1978



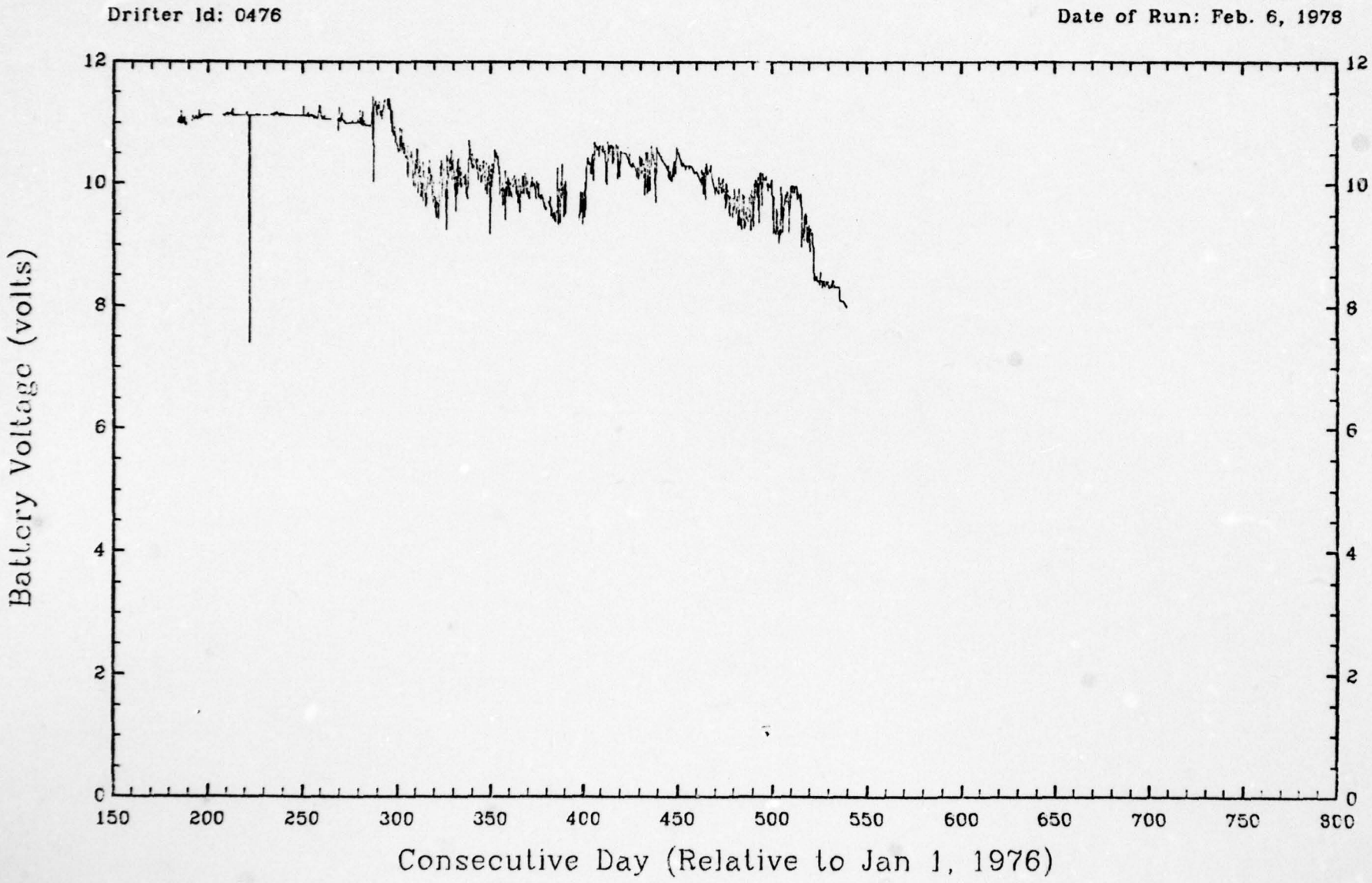
Date of Run: Mar. 17, 1978

Period Covered:
June 1, 1976 to Mar. 17, 1978

Symbol	Drifter Id
A	0476

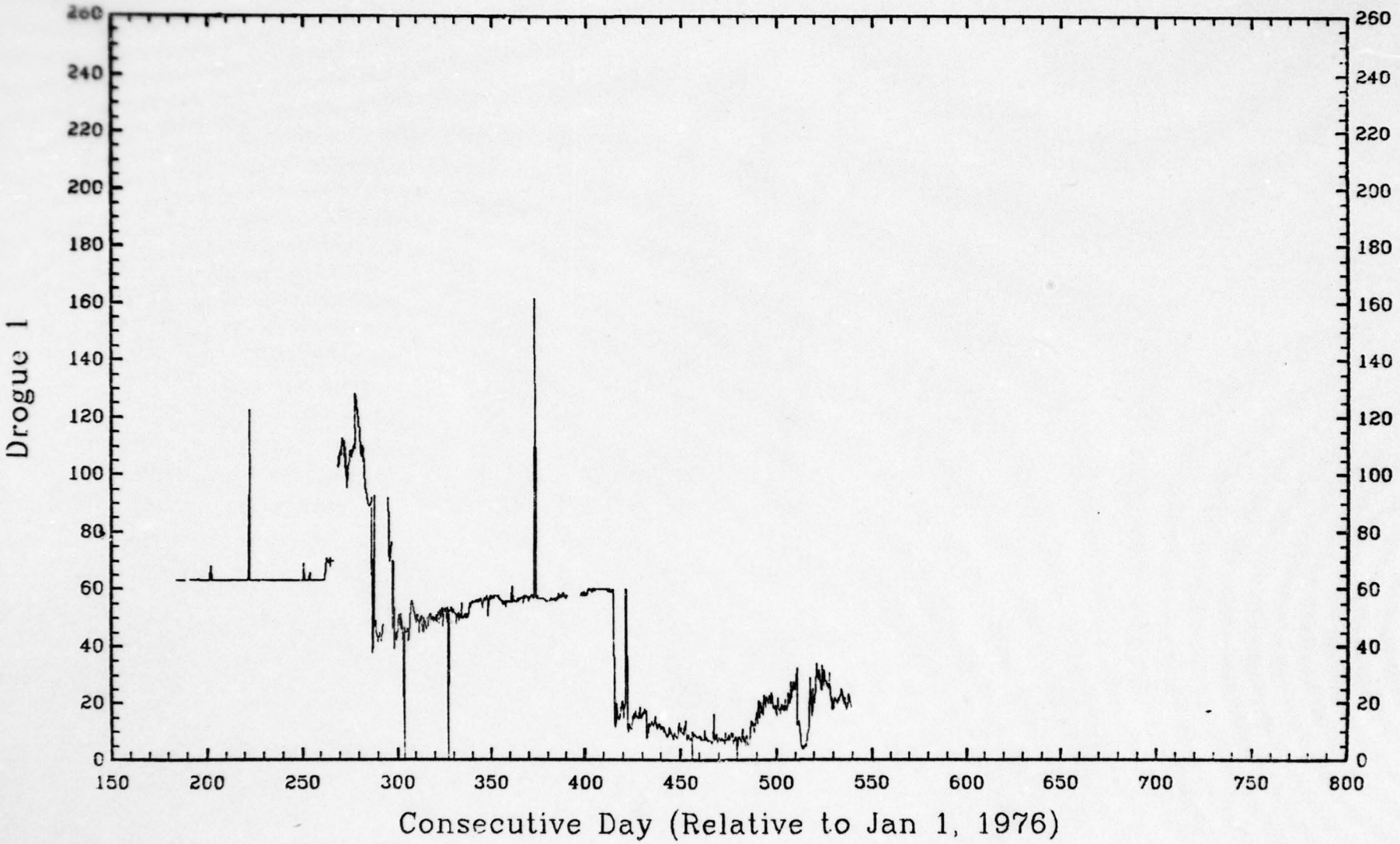


Drifter Trajectories
Positions Computed by Interpolation


Drifter Id: 0476
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Conseculive Day (Relative to Jan 1, 1976)

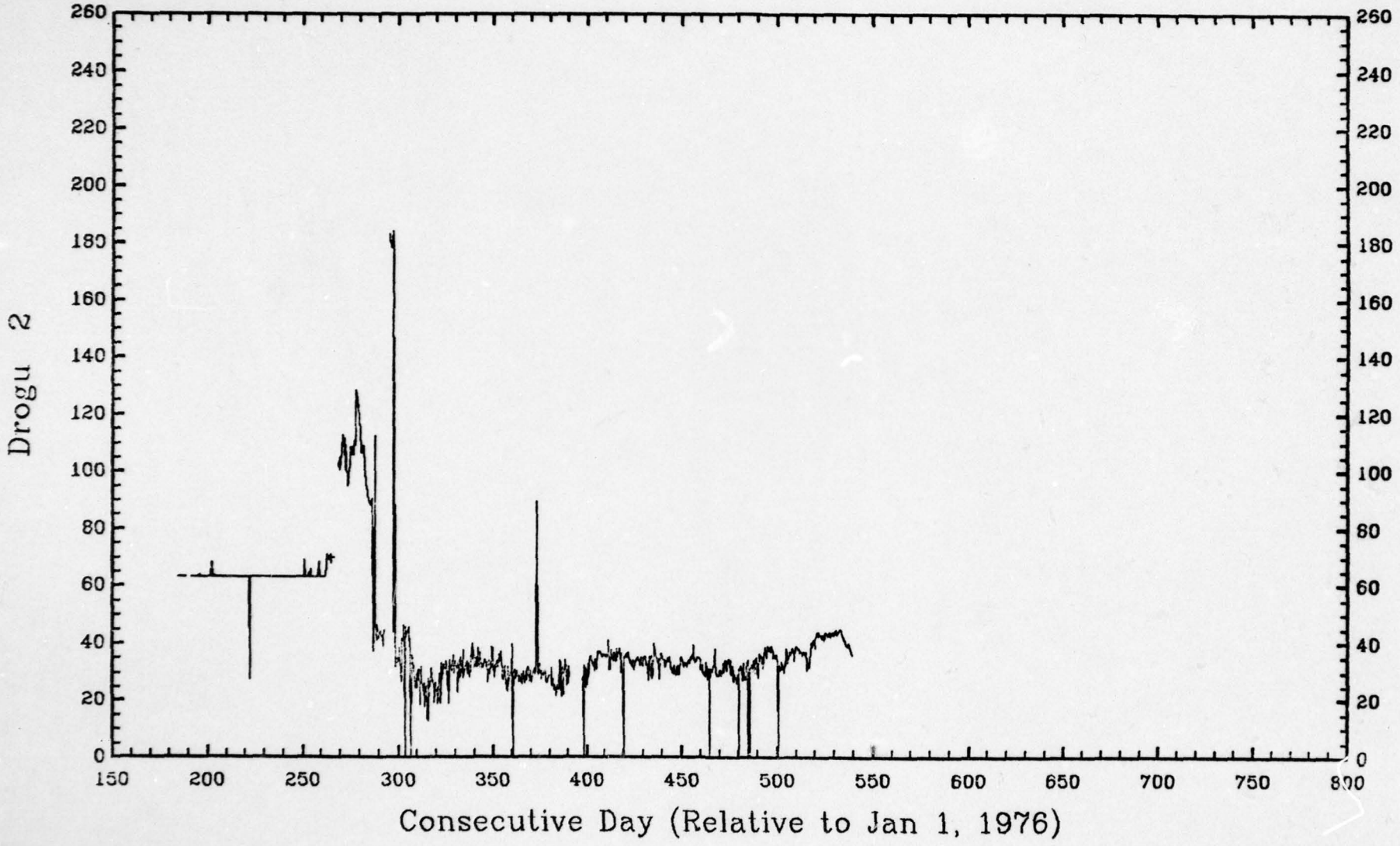
Drifter Id: 0476

Date of Run: Feb. 6, 1978



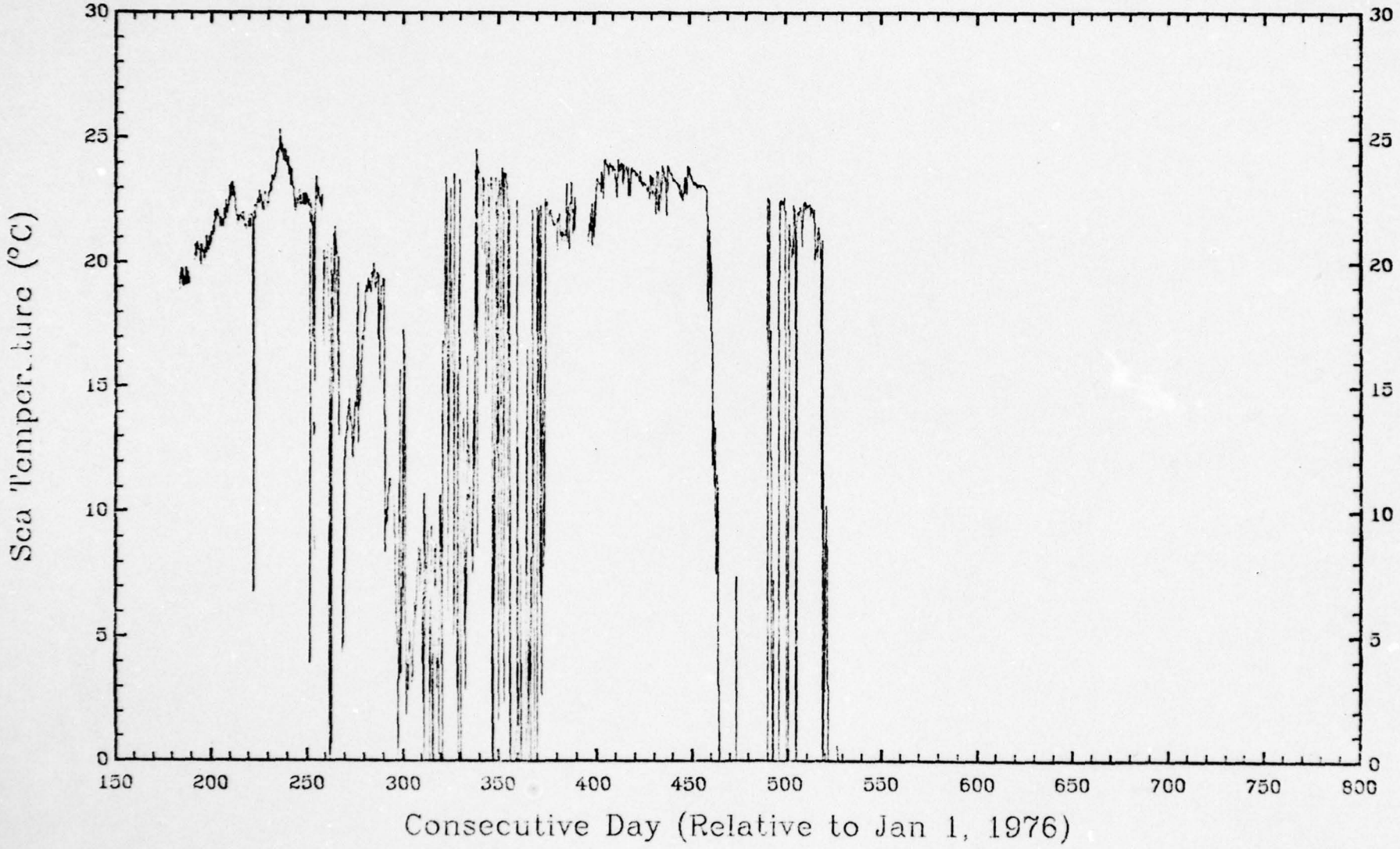
Drifter Id: 0476

Date of Run: Feb. 6, 1976



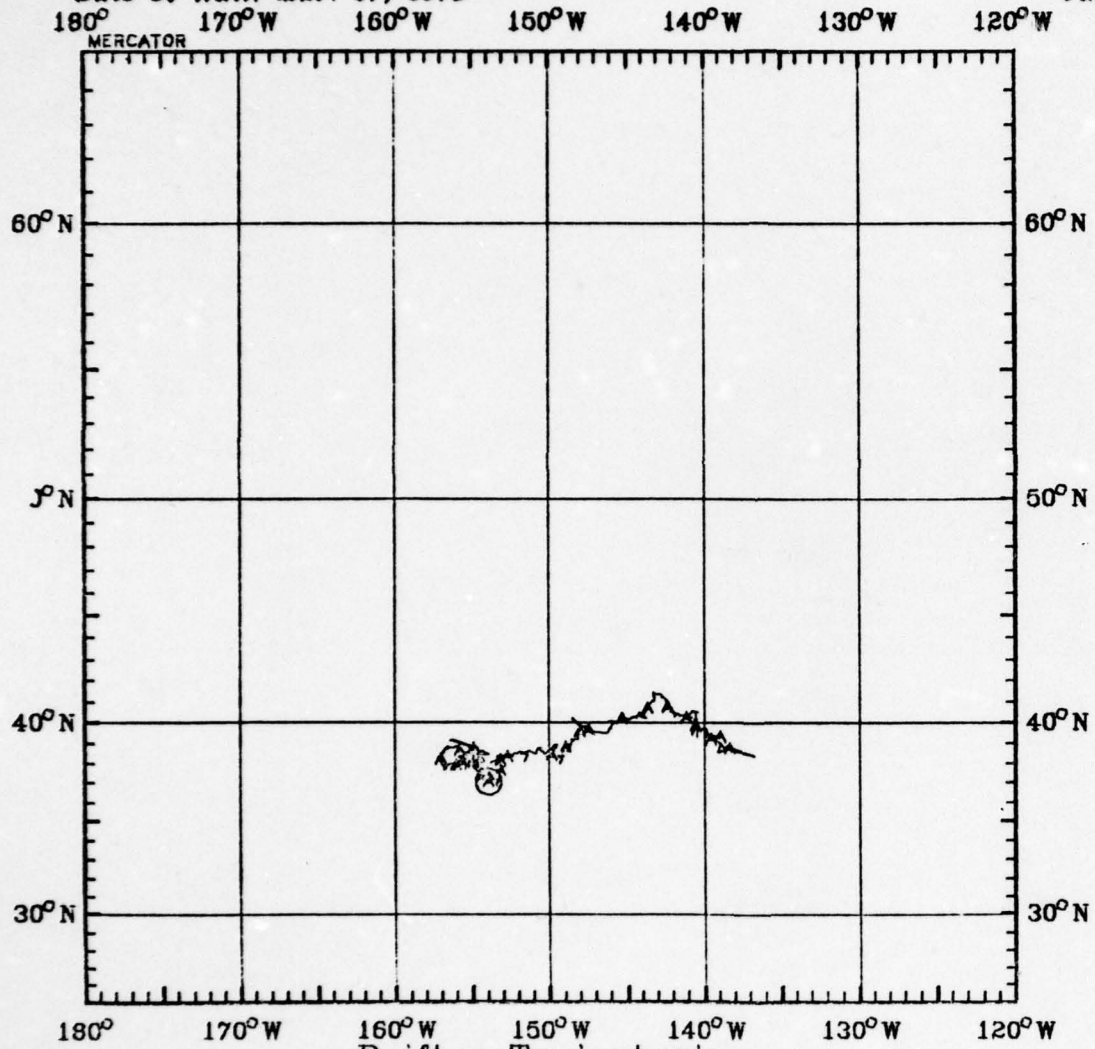
Drifter Id: 0476

Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1978

Period Covered:
June 1, 1976 to Mar. 17, 1978



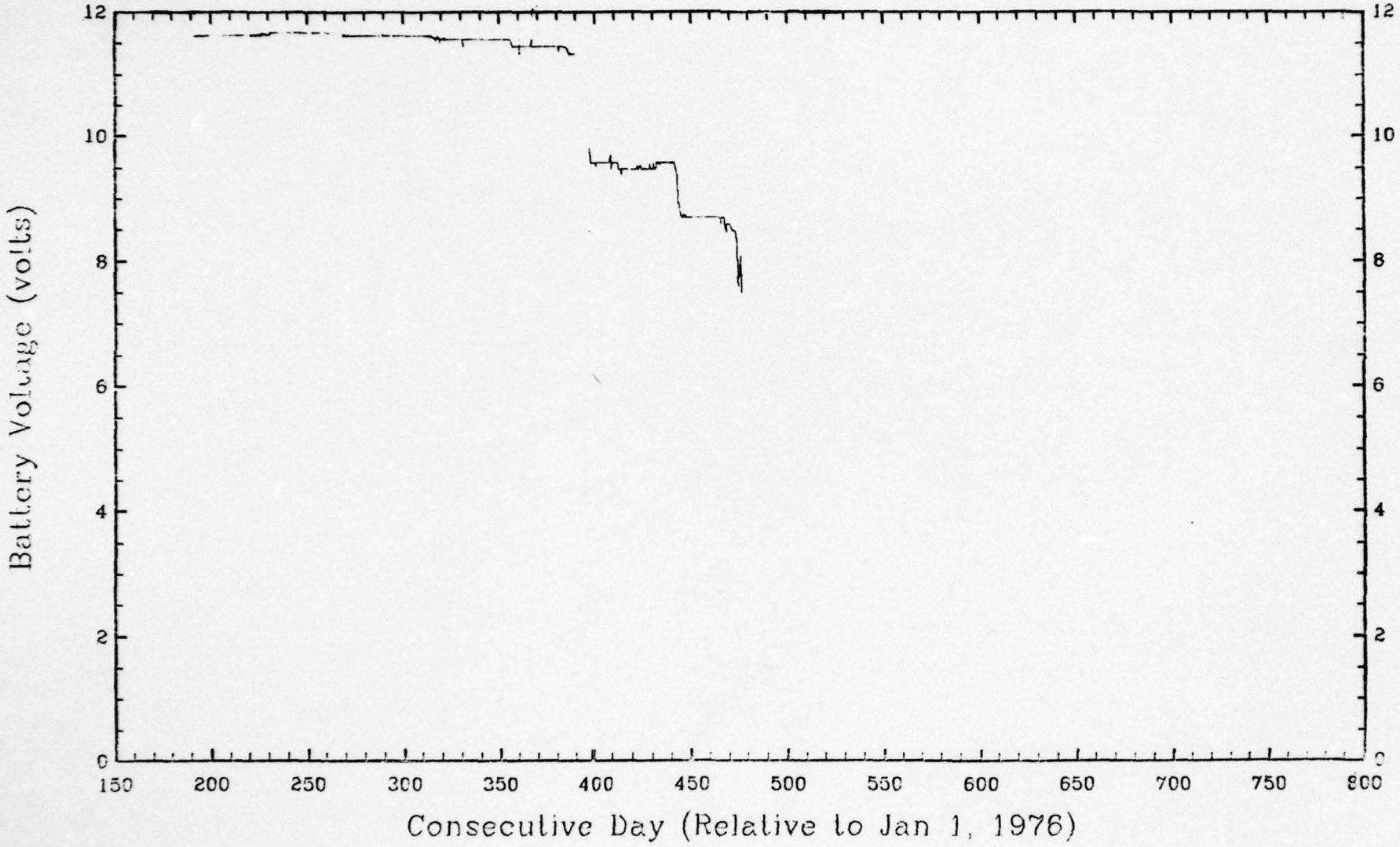
Symbol	Drifter Id
^	0701

Drifter Trajectories

Positions Computed by Interpolation

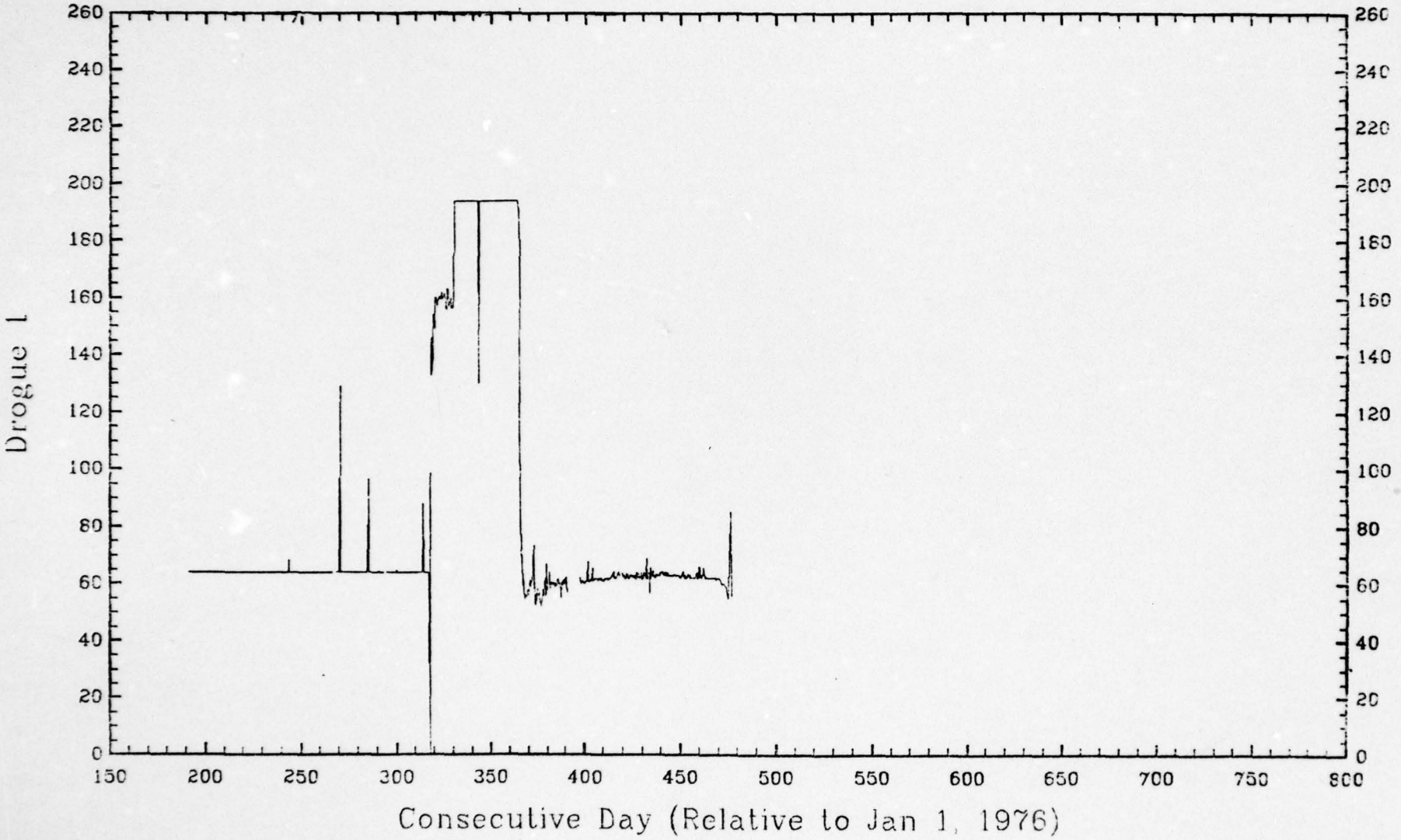
Drifter Id: 0701

Date of Run: Feb. 6, 1978



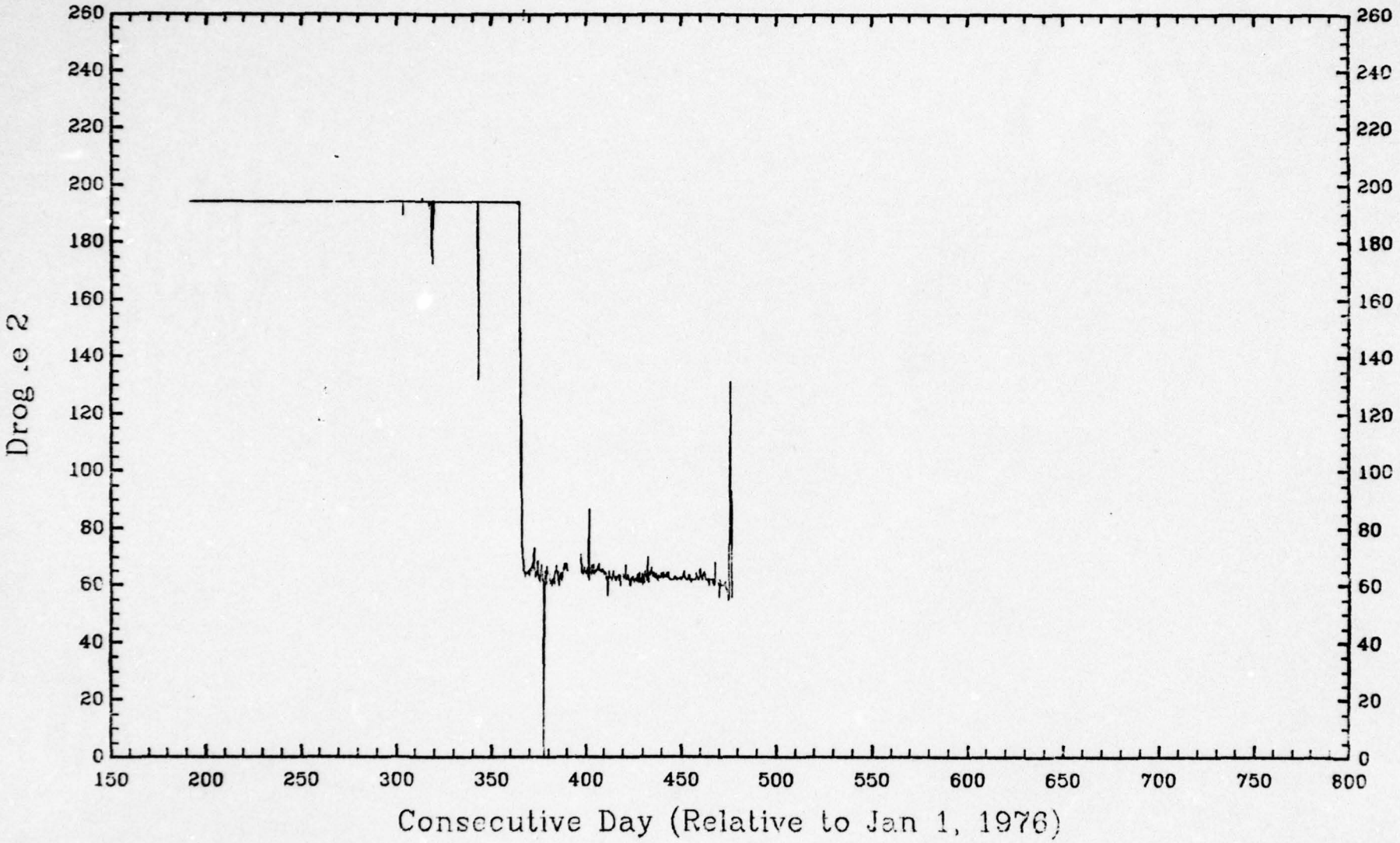
Drifter Id: 0701

Date of Run: Feb. 6, 1978



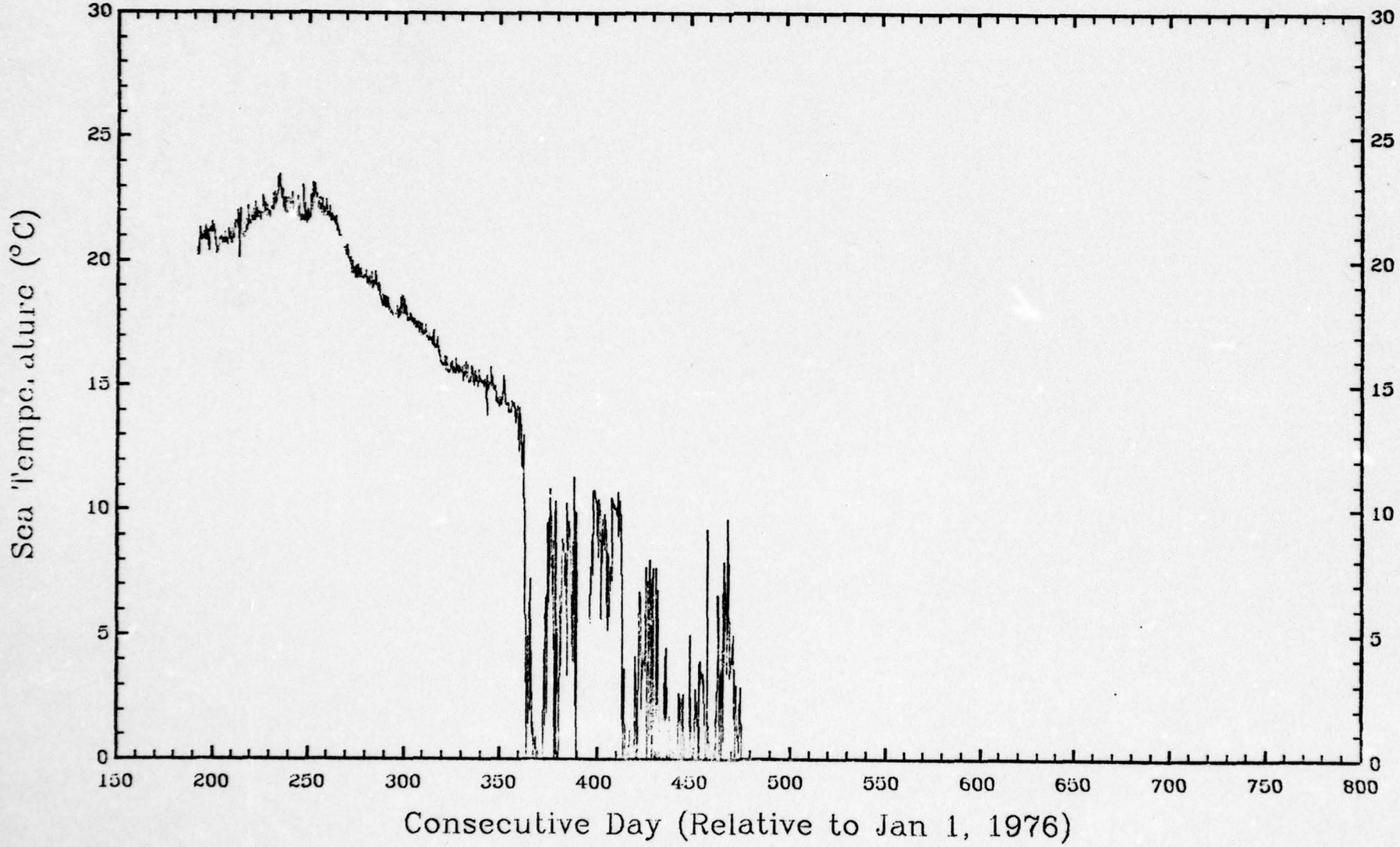
Drifter Id: 0701

Date of Run: Feb. 6, 1978



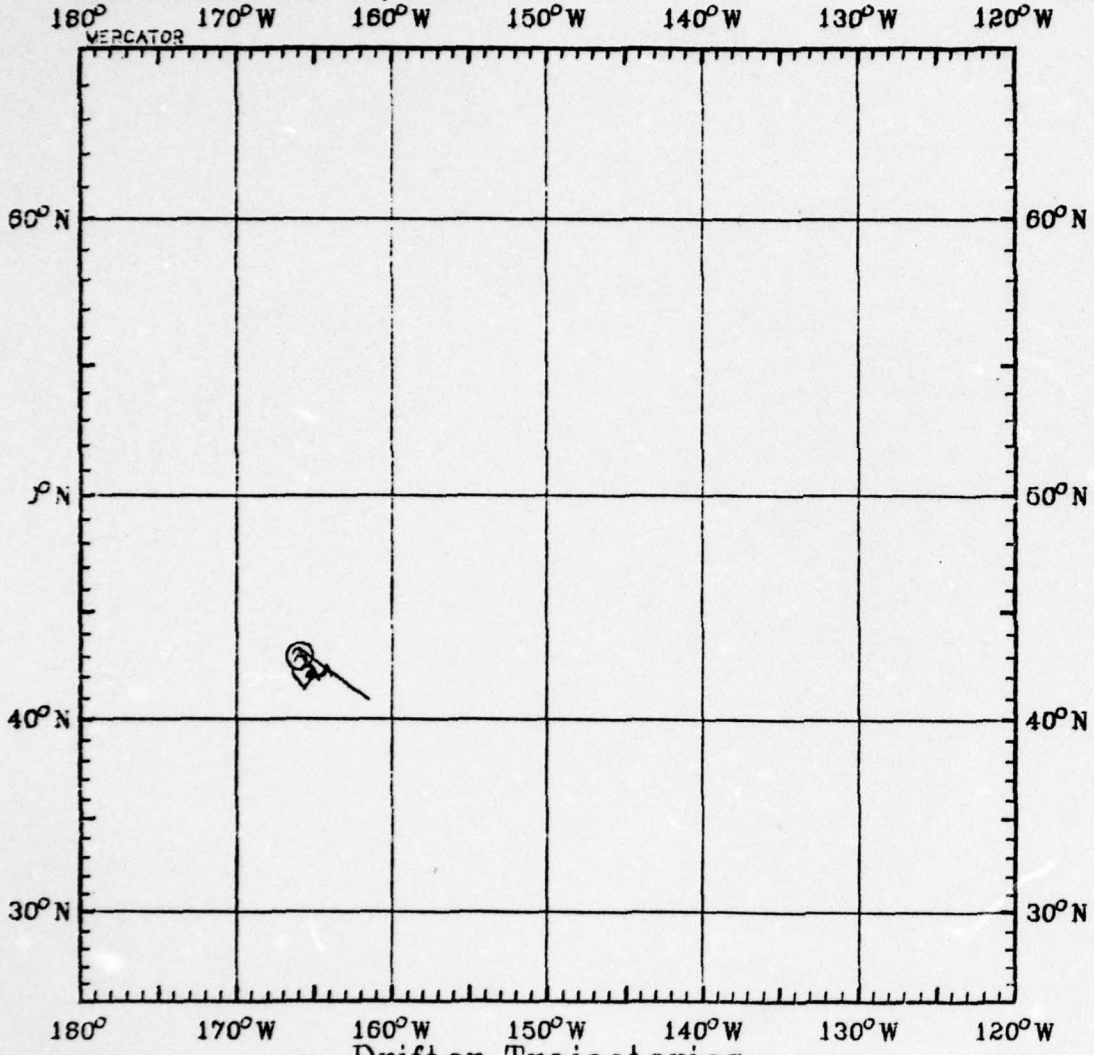
Drifter Id: 0701

Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1978

Period Covered:
June 27, 1976 to Aug. 20, 1976

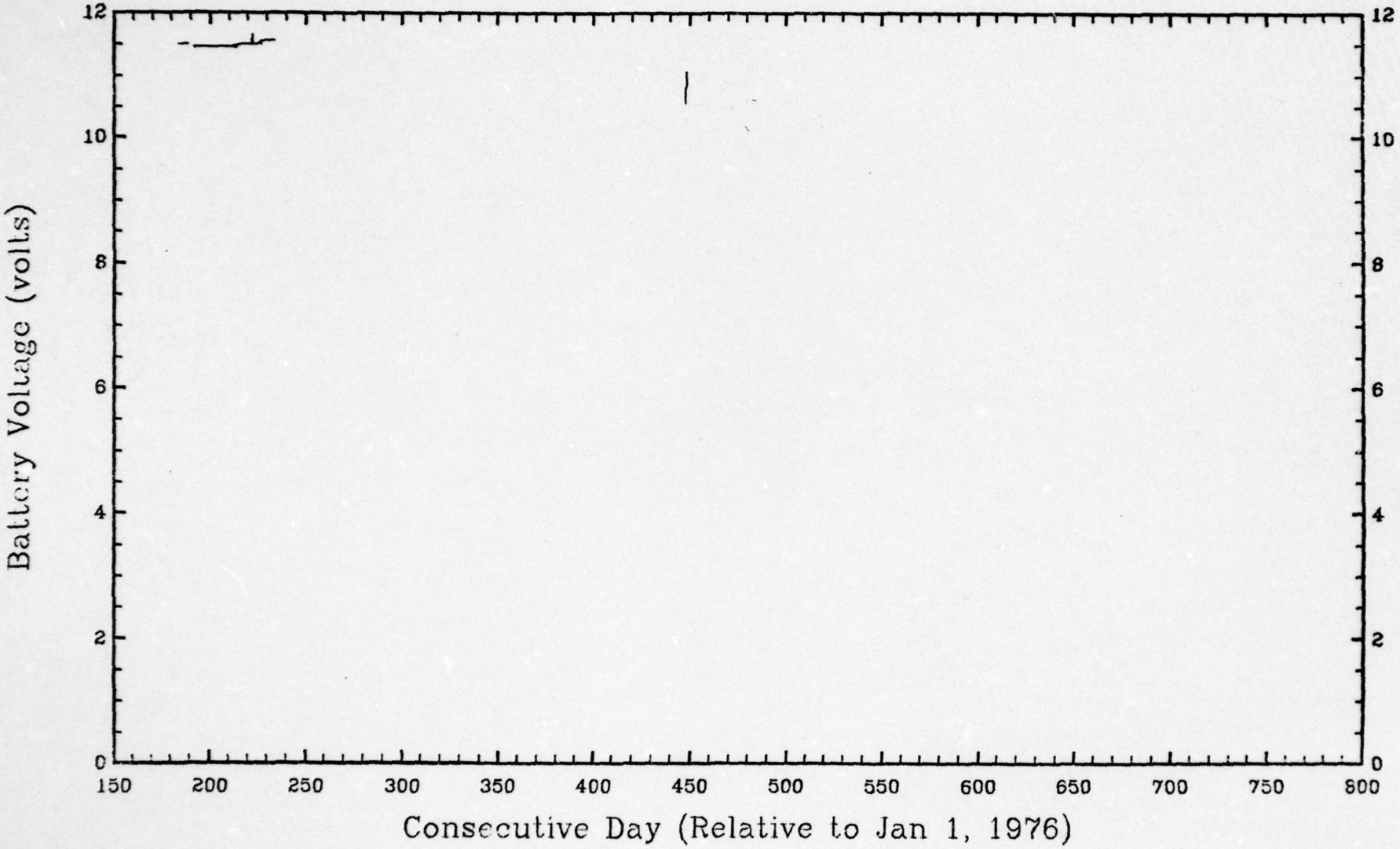


Symbol	Drifter Id
A	0737

Drifter Trajectories
Positions Computed by Interpolation

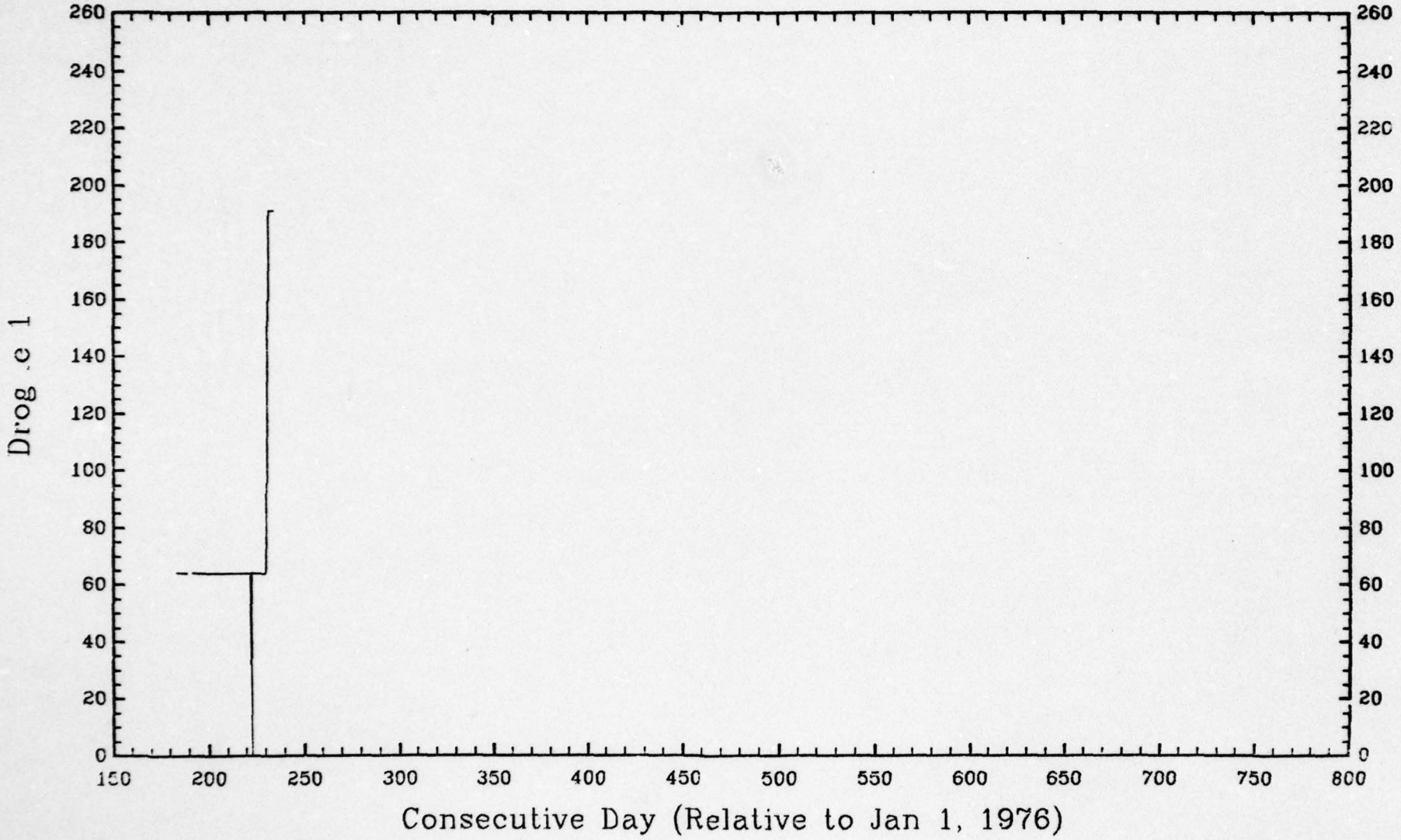
Drifter Id: 0737

Date of Run: Feb. 6, 1976



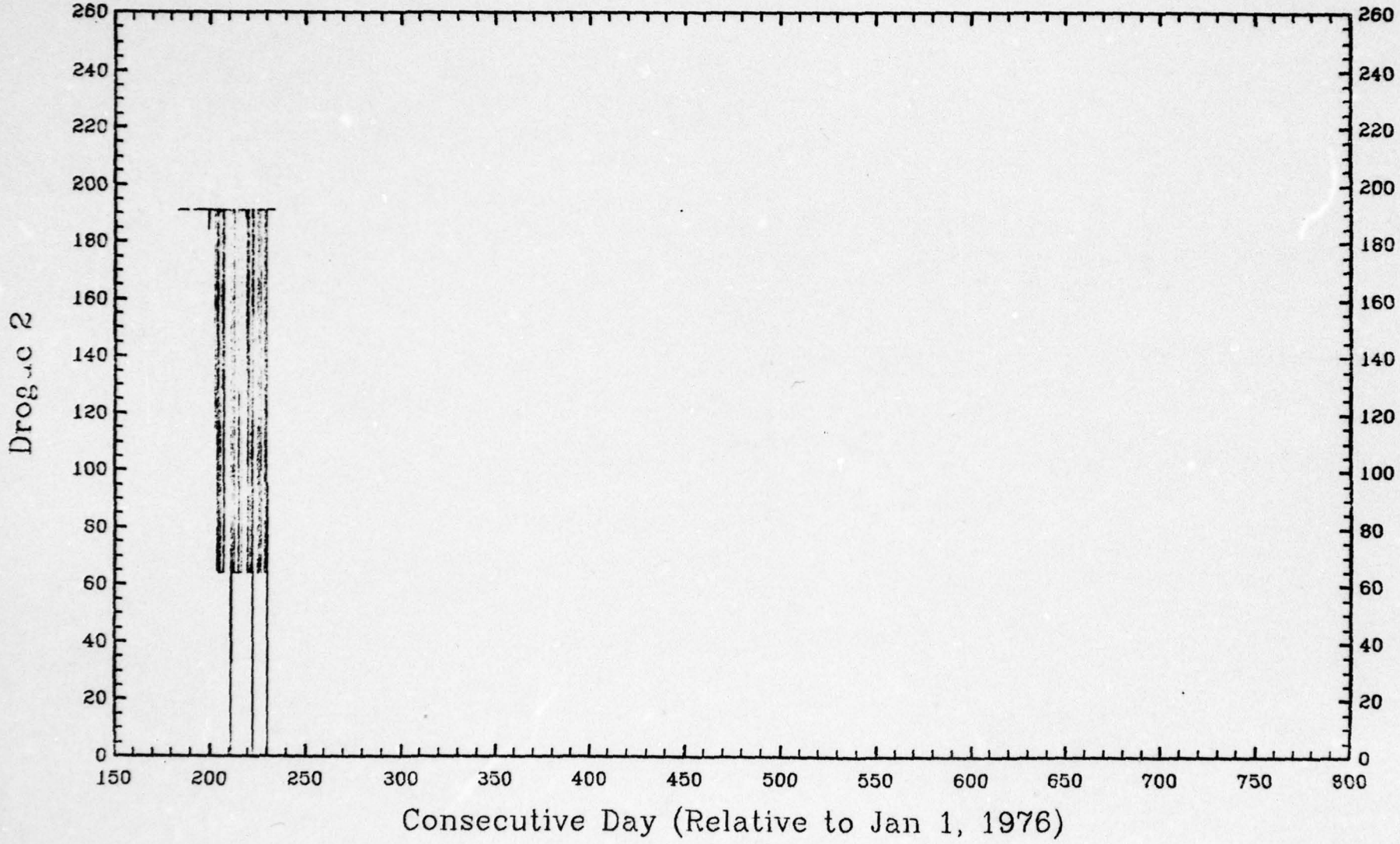
Drifter Id: 0737

Date of Run: Feb. 6, 1978



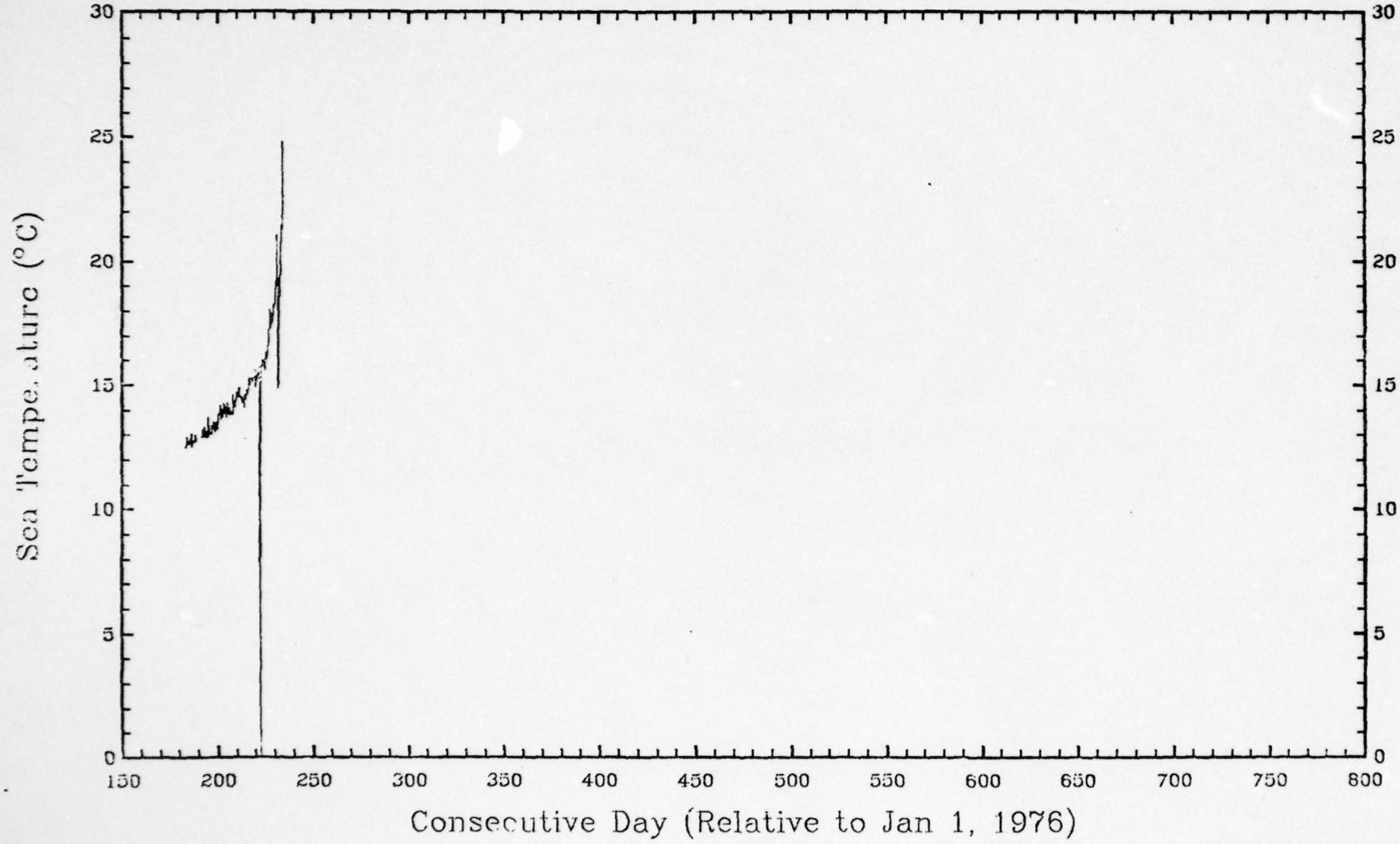
Drifter Id: 0737

Date of Run: Feb. 6, 1978



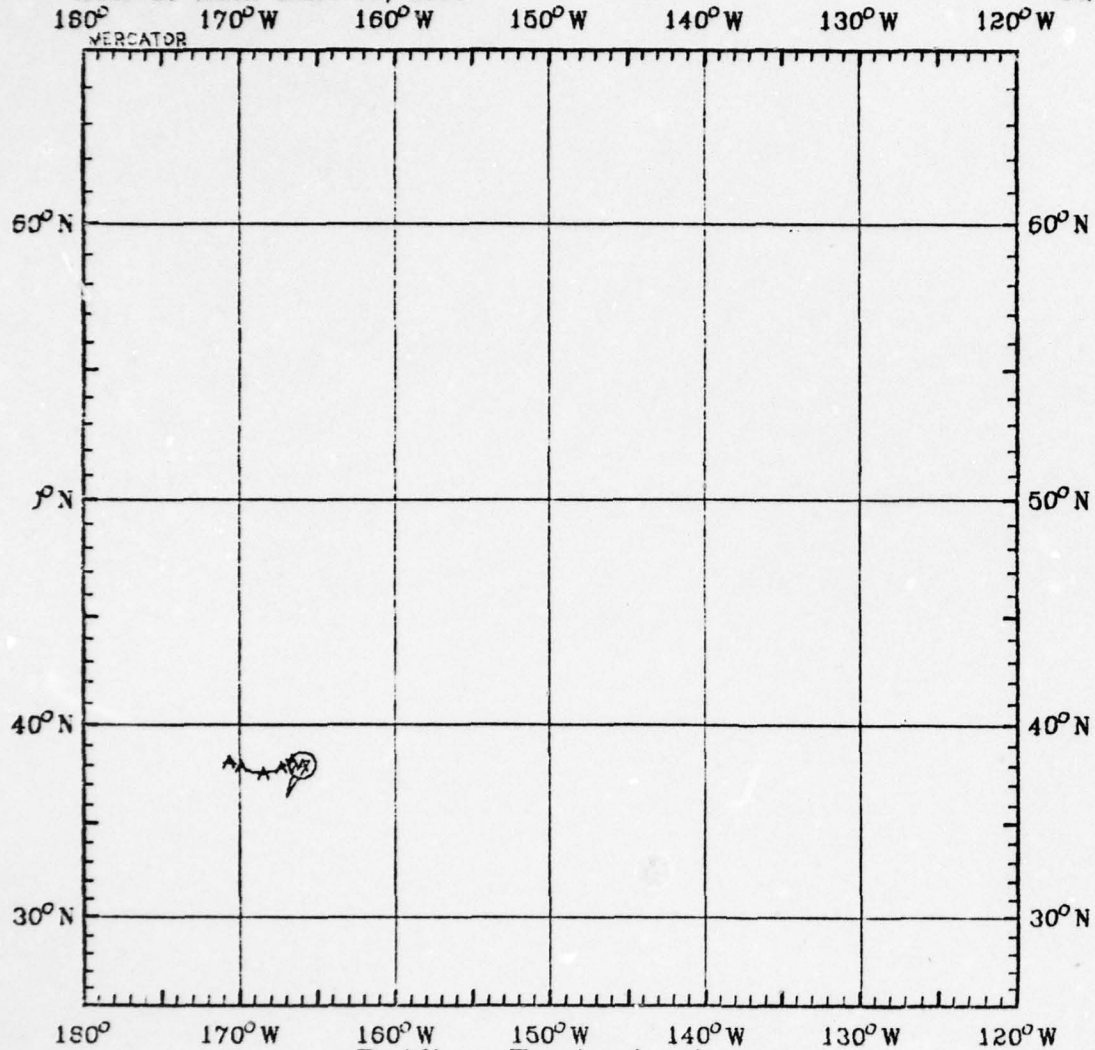
Drifter Id: 0737

Date of Run: Feb. 6, 1978



Date of Run: Mar. 17, 1978

Period Covered:
June 29, 1976 to Sept. 2, 1976



Symbol	Drifter Id
^	0746

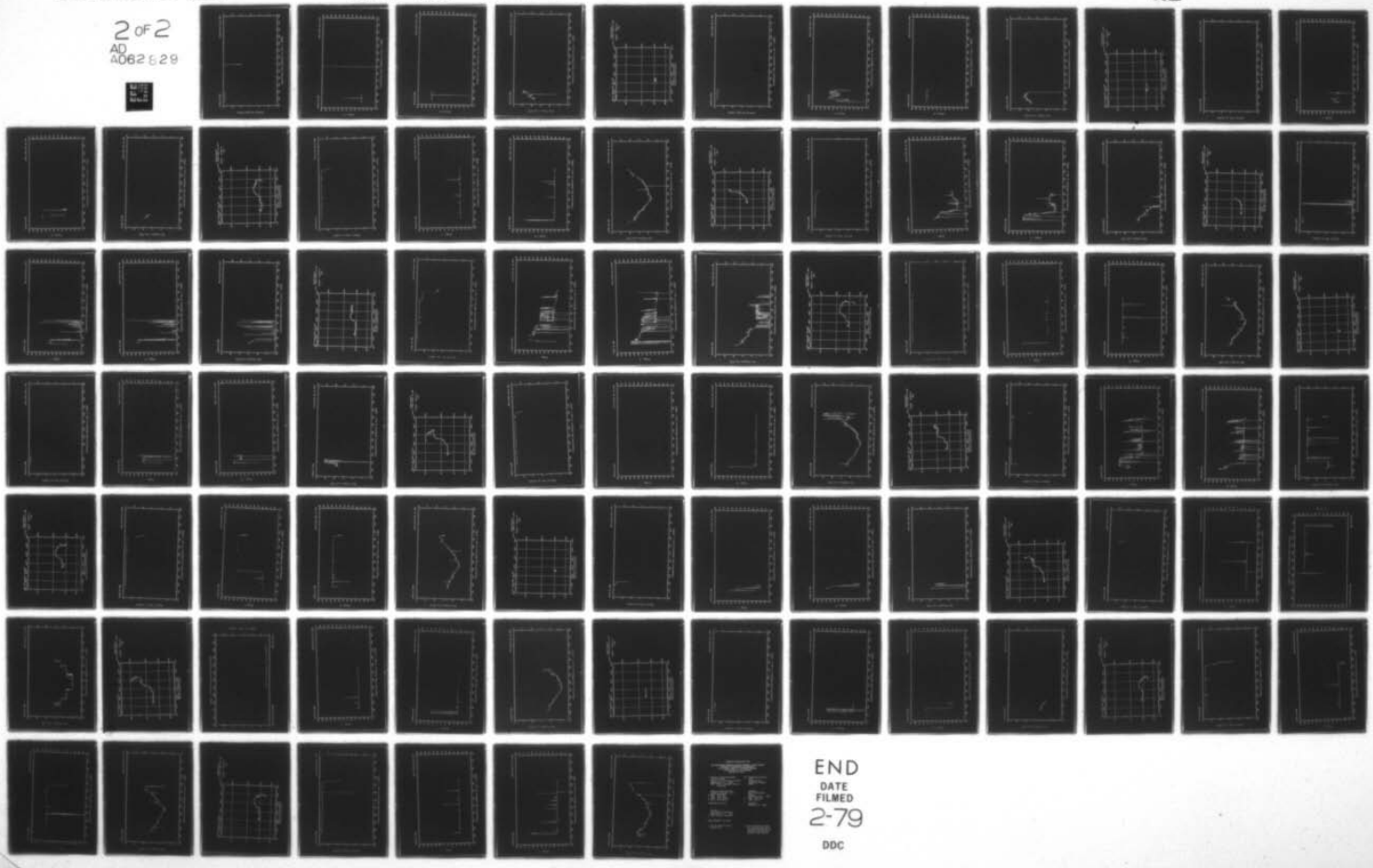
Drifter Trajectories

Positions Computed by Interpolation

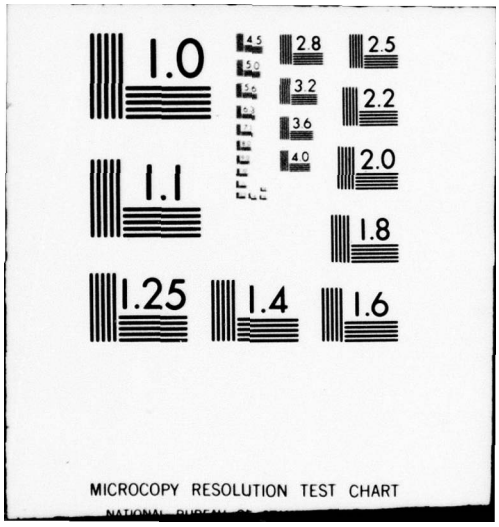
AD-A062 829 TEXAS A AND M UNIV COLLEGE STATION DEPT OF OCEANOGRAPHY F/G 8/3
TECHNICAL EVALUATION OF ADS I AND II DRIFTER PERFORMANCE.(U)
APR 78 G MCNALLY, E REYNA, W J MERRELL N00015-75-C-1052

UNCLASSIFIED TAMU-REF-78-3-T NL

2 OF 2
AD
A062 829

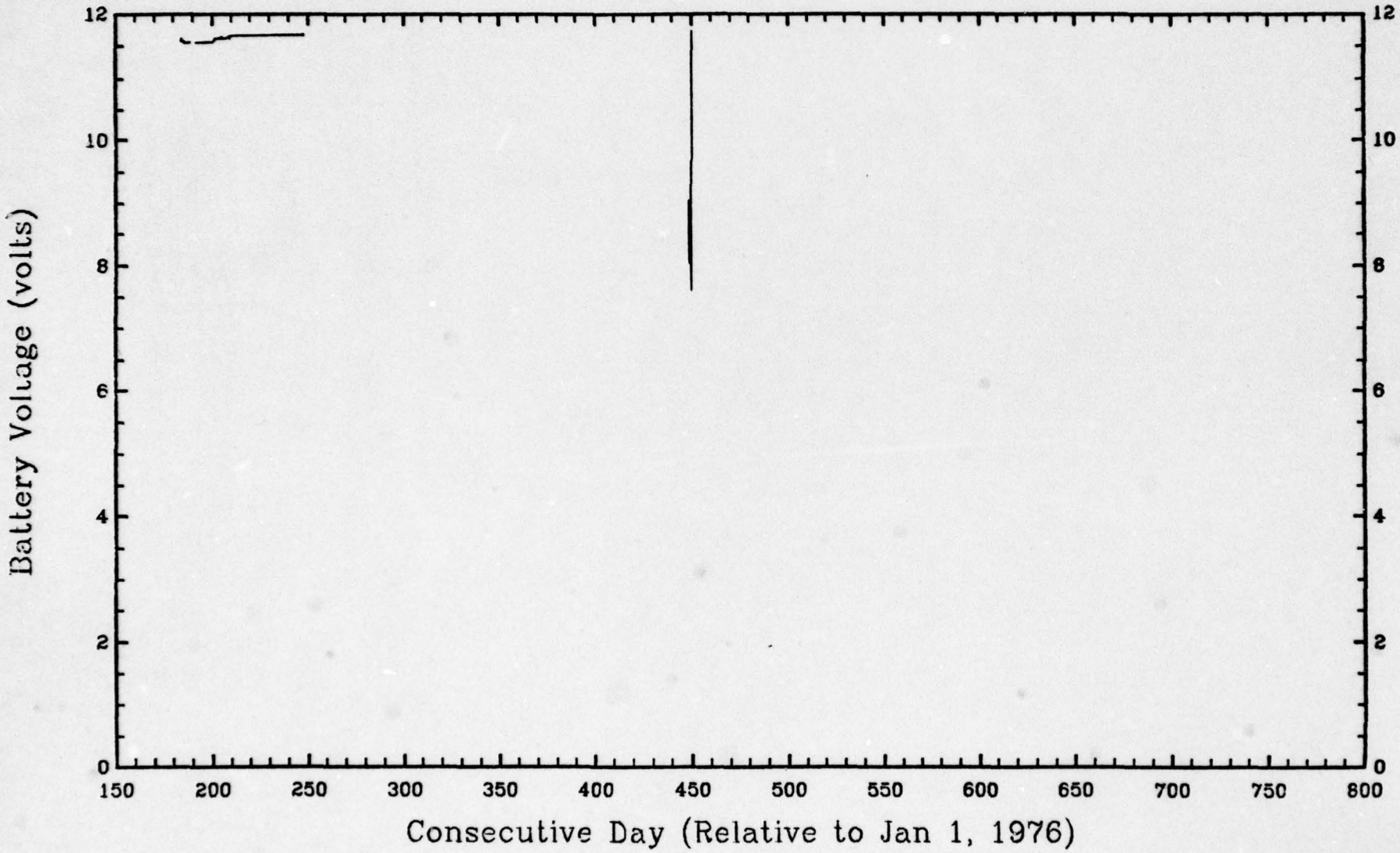


END
DATE
FILMED
2-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART

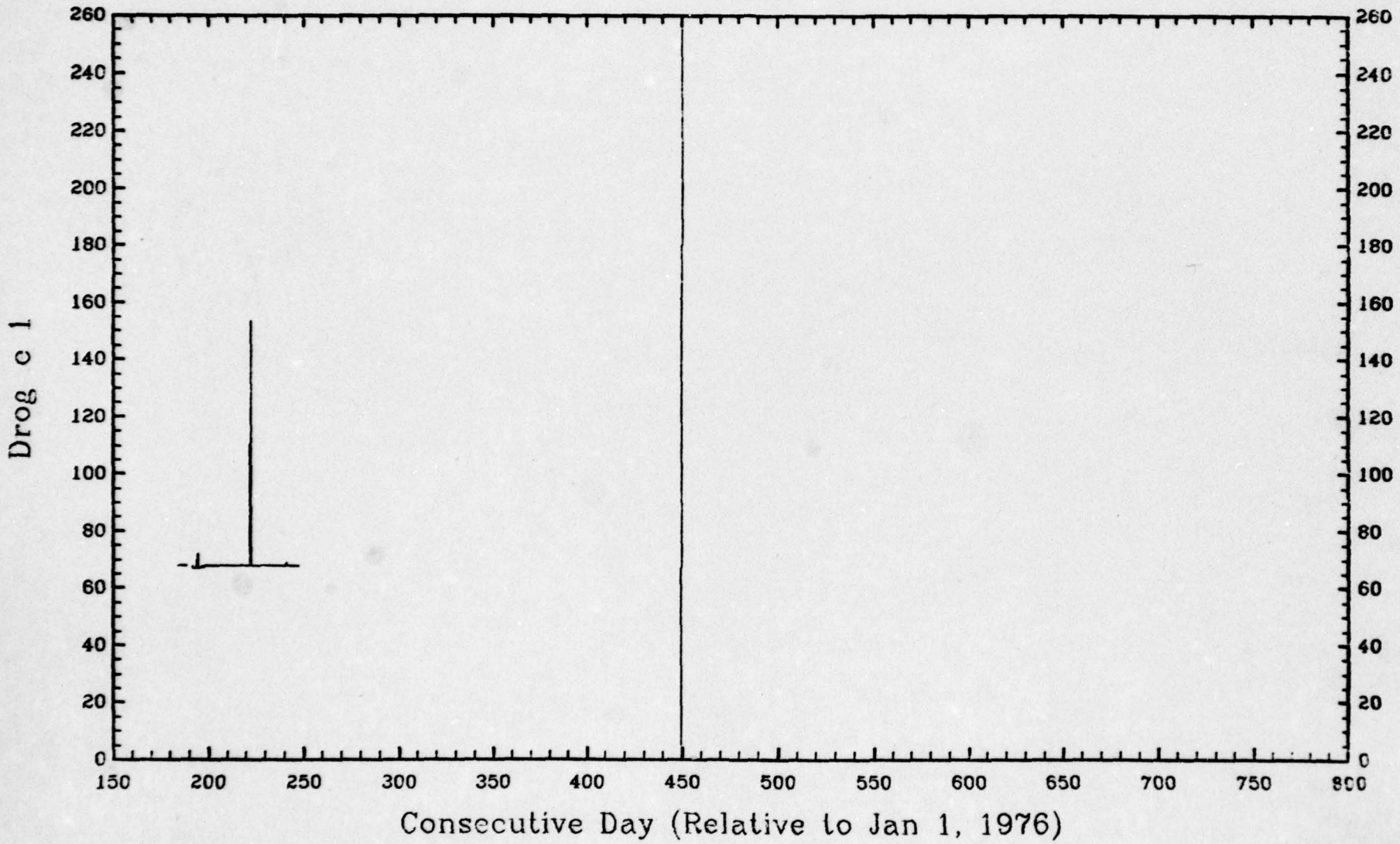
Drifter Id: 0746

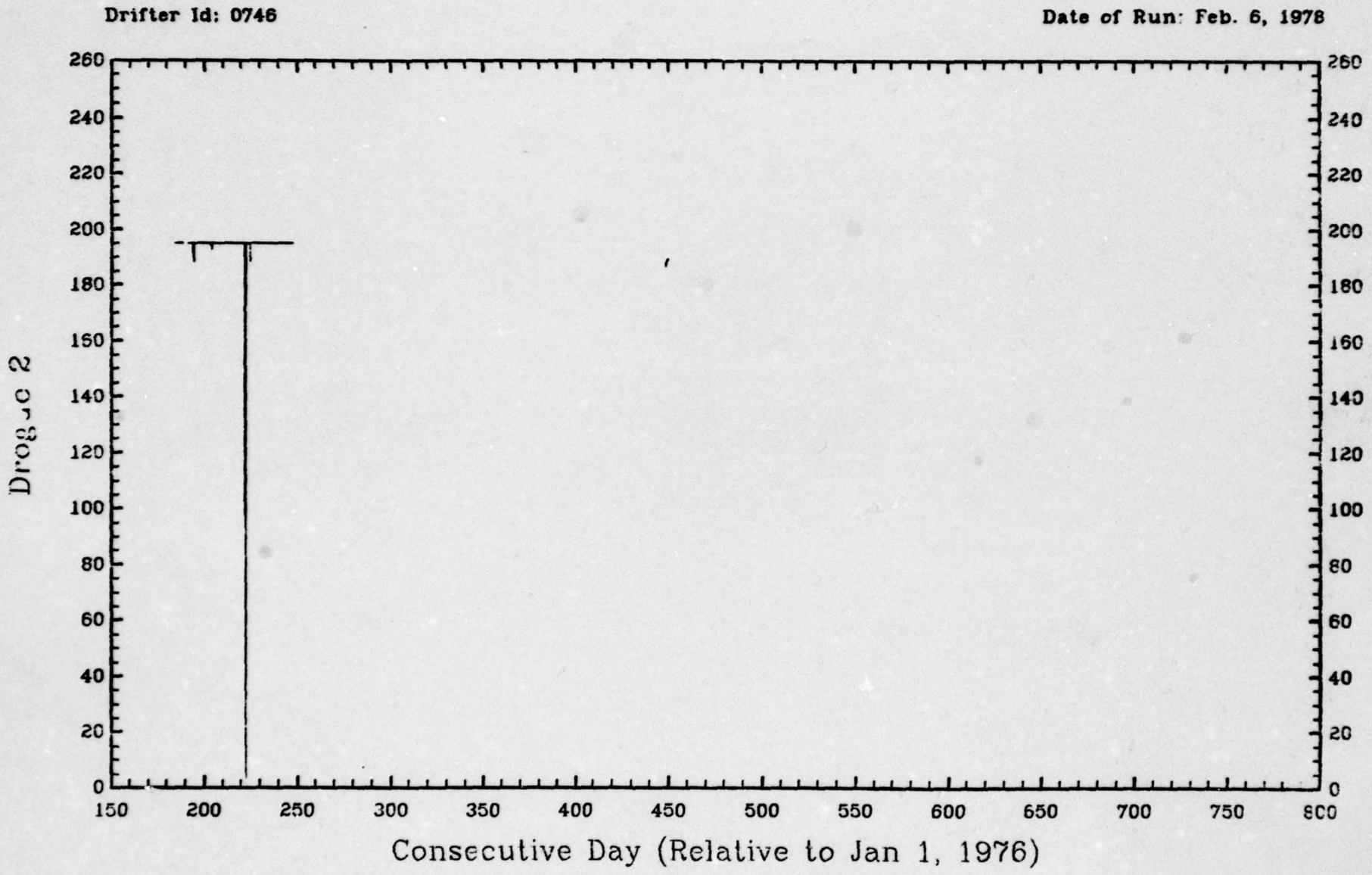
Date of Run: Feb. 6, 1976



Drifter Id: 0746

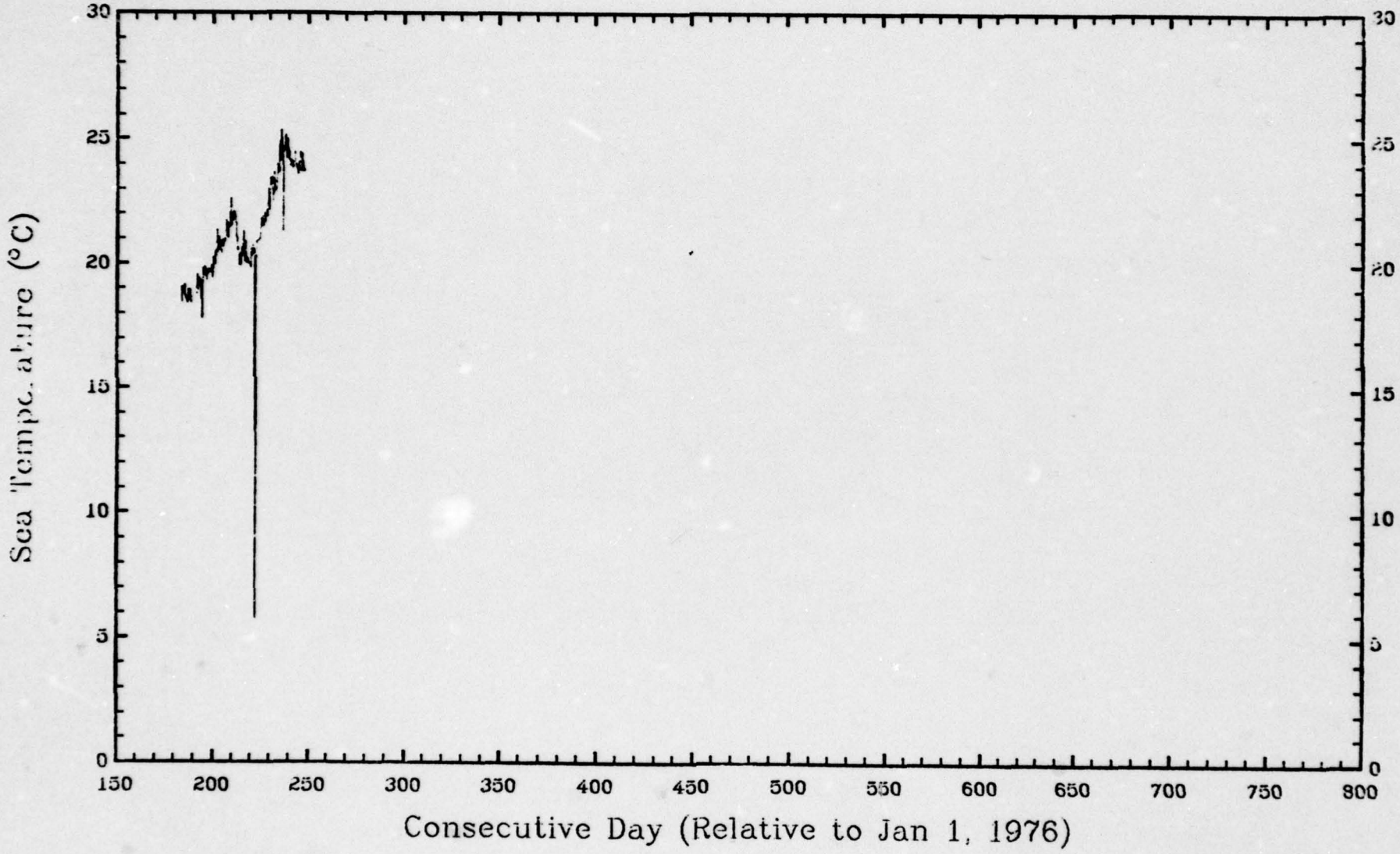
Date of Run: Feb. 6, 1978




Drifter Id: 0746
Date of Run: Feb. 6, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
150
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

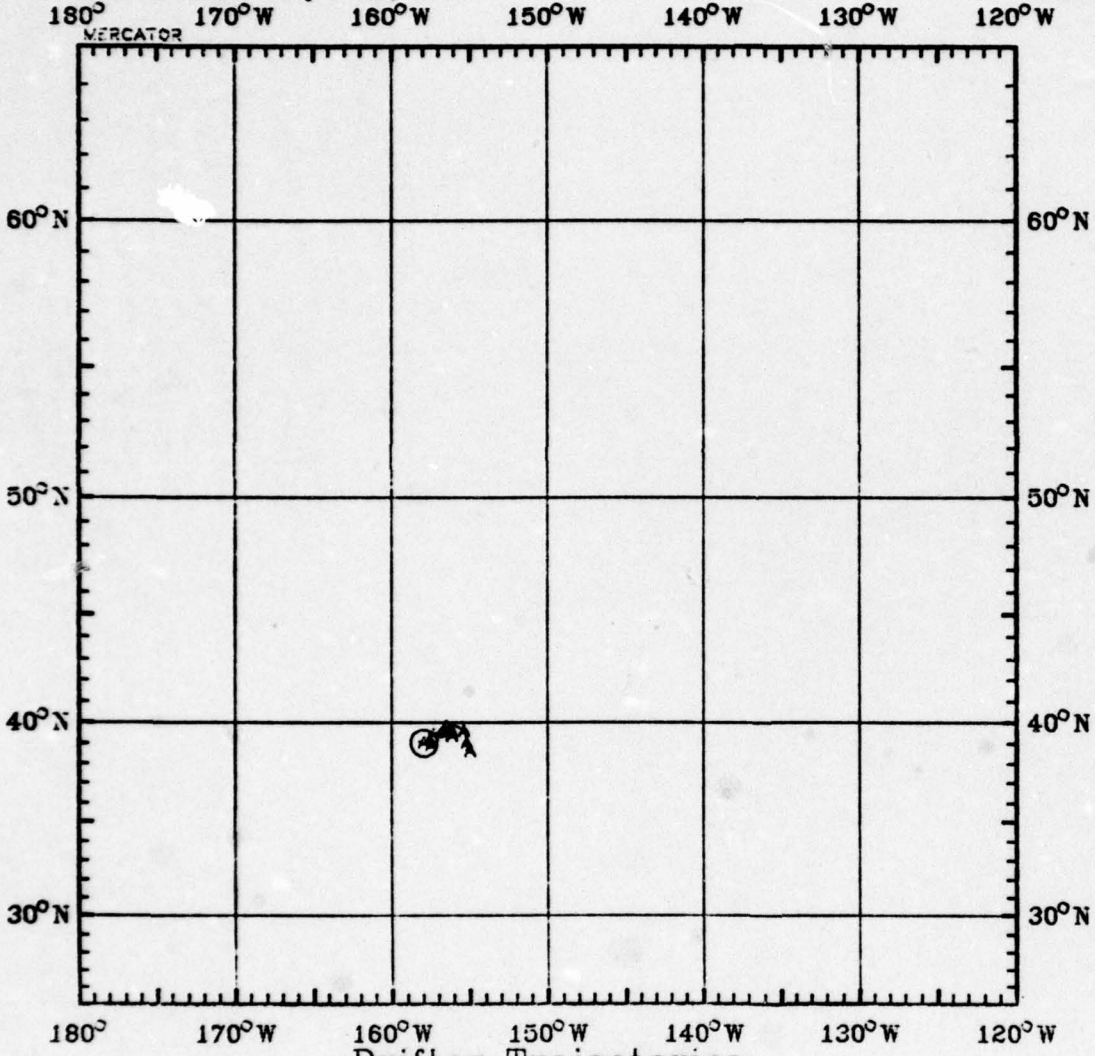
Drifter Id: 0746

Date of Run: Feb. 6, 1978



Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

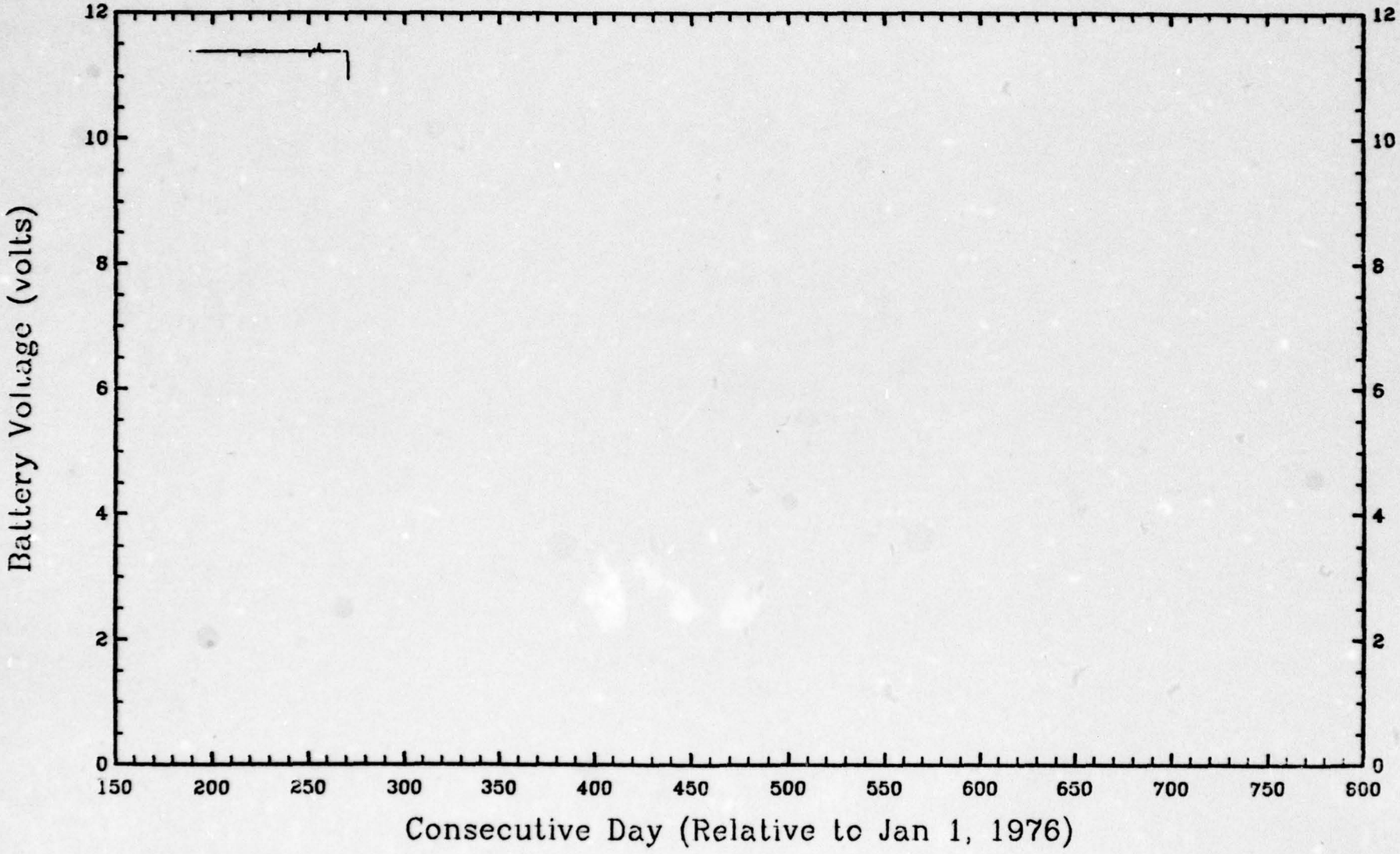


Symbol	Drifter Id
A	0770

Drifter Trajectories
Velocity Checked Positions

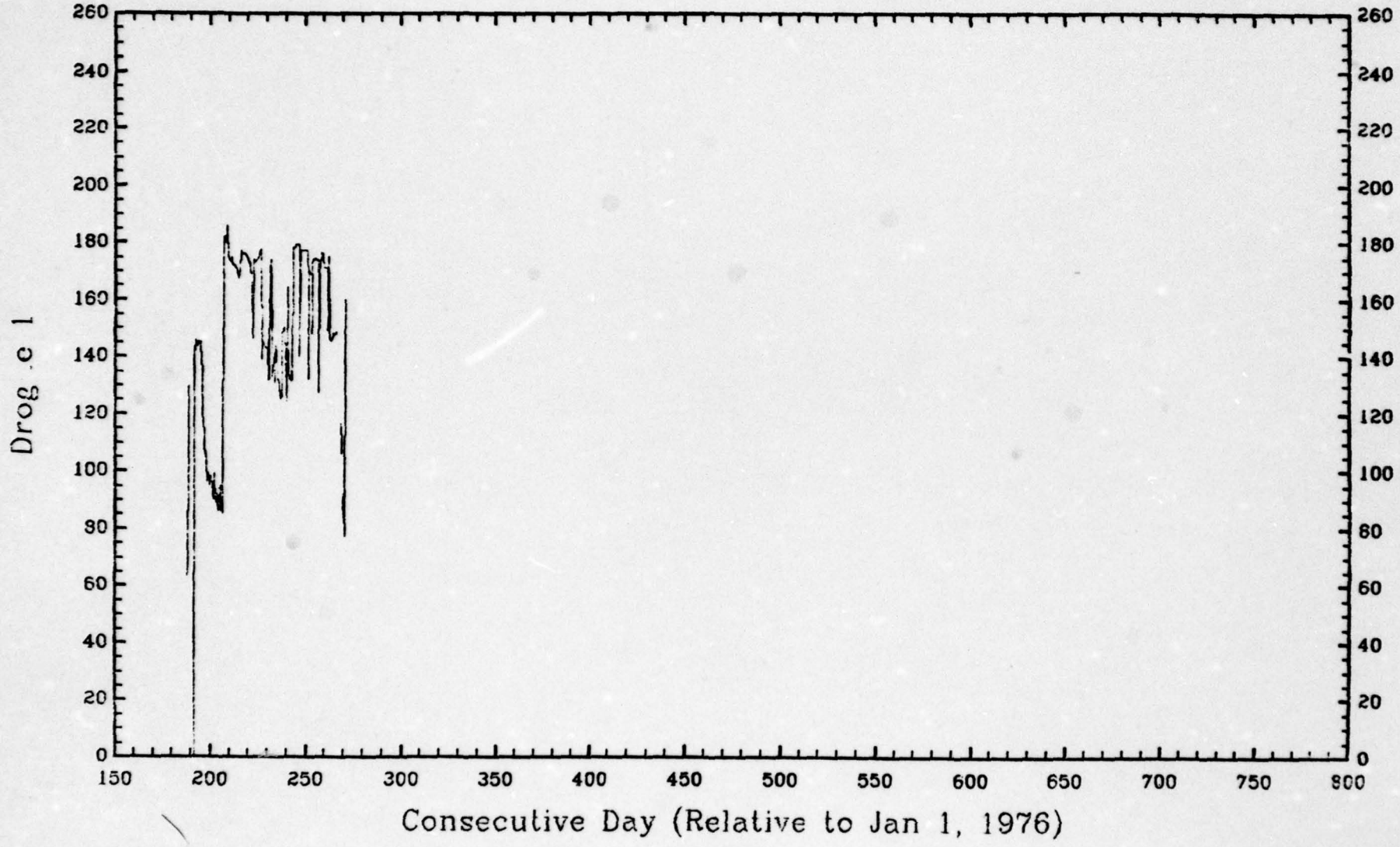
Drifter Id: 0770

Date of Run: Feb. 6, 1978



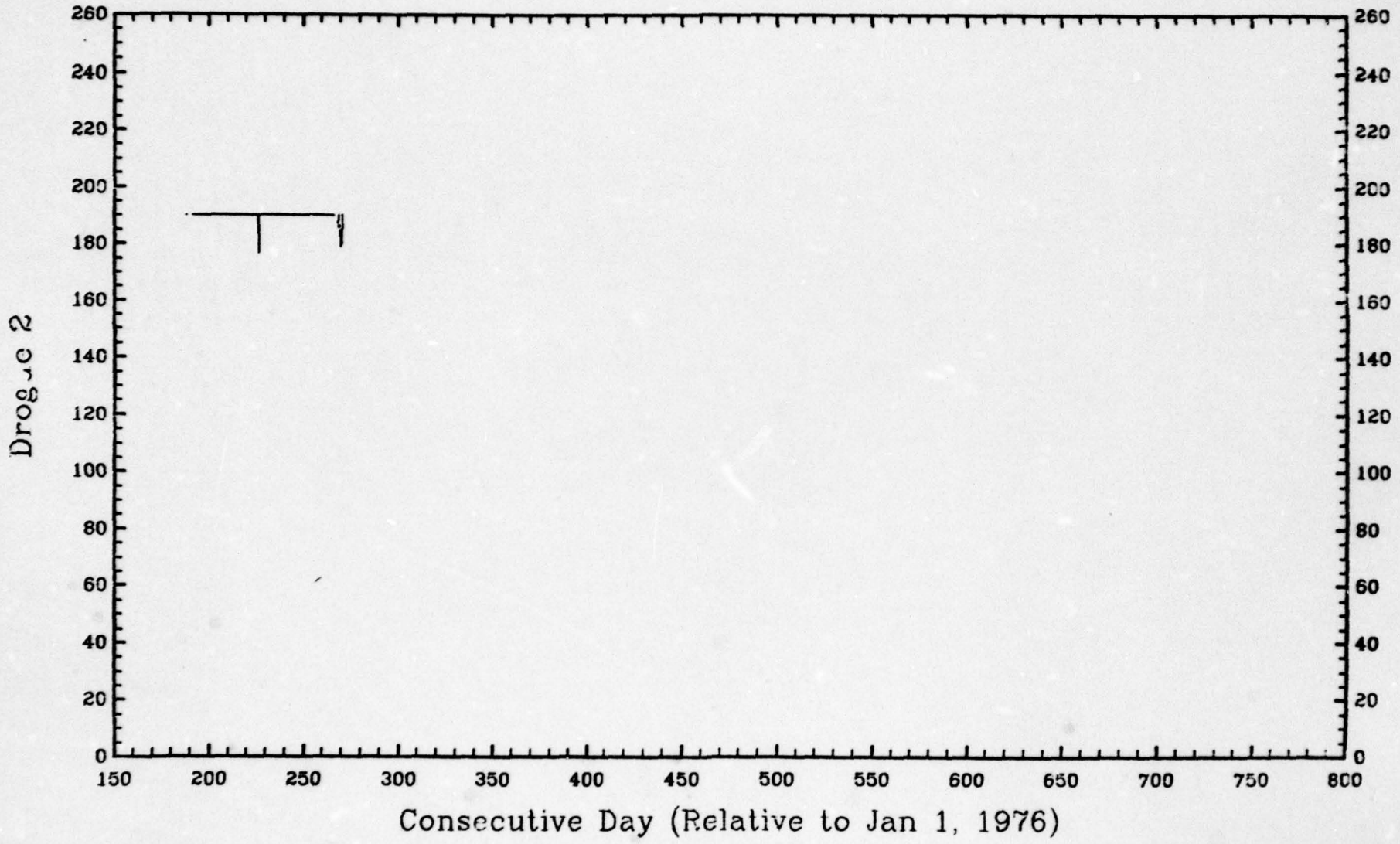
Drifter Id: 0770

Date of Run: Feb. 6, 1978



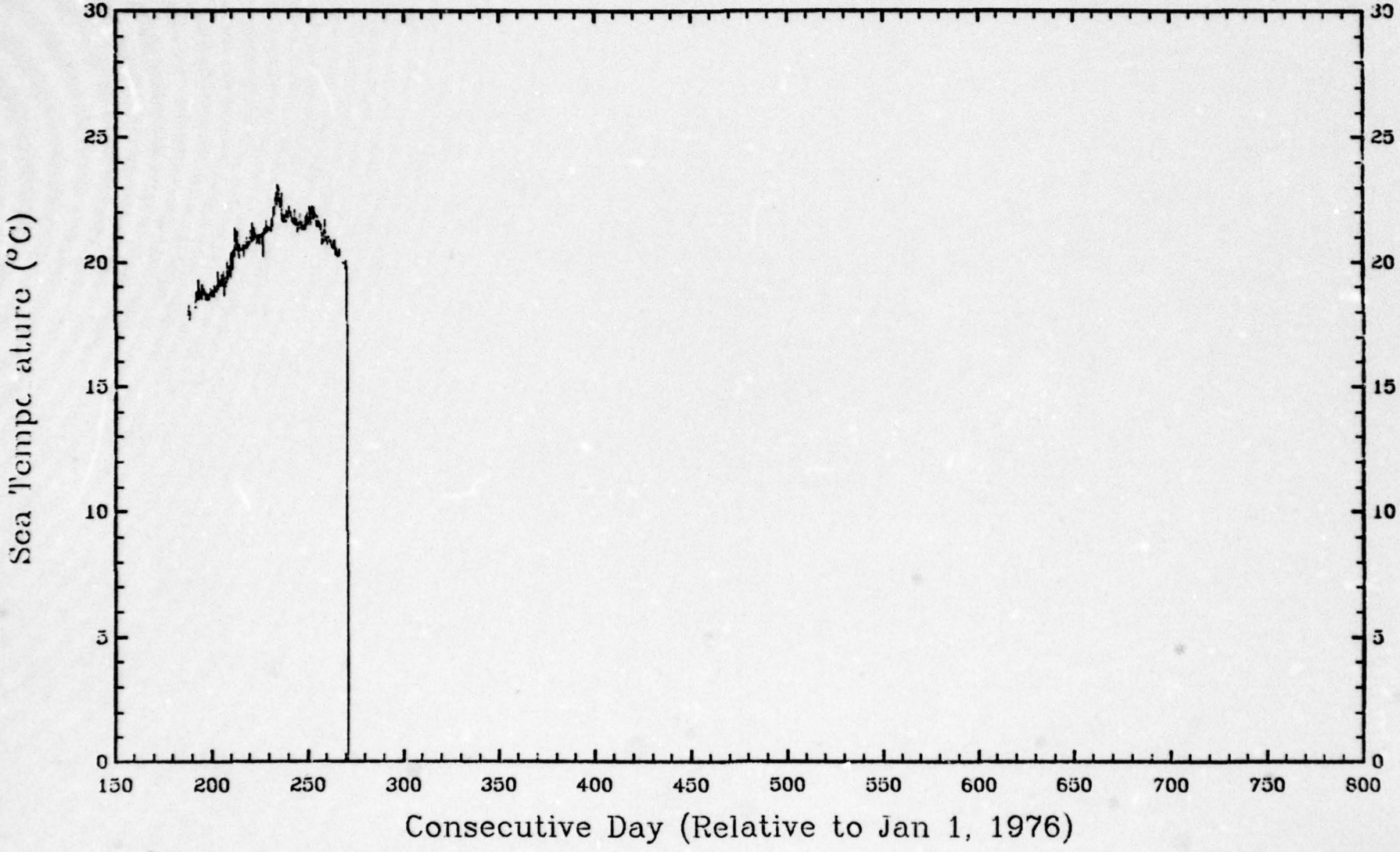
Drifter Id: 0770

Date of Run: Feb. 6, 1978



Drifter Id: 0770

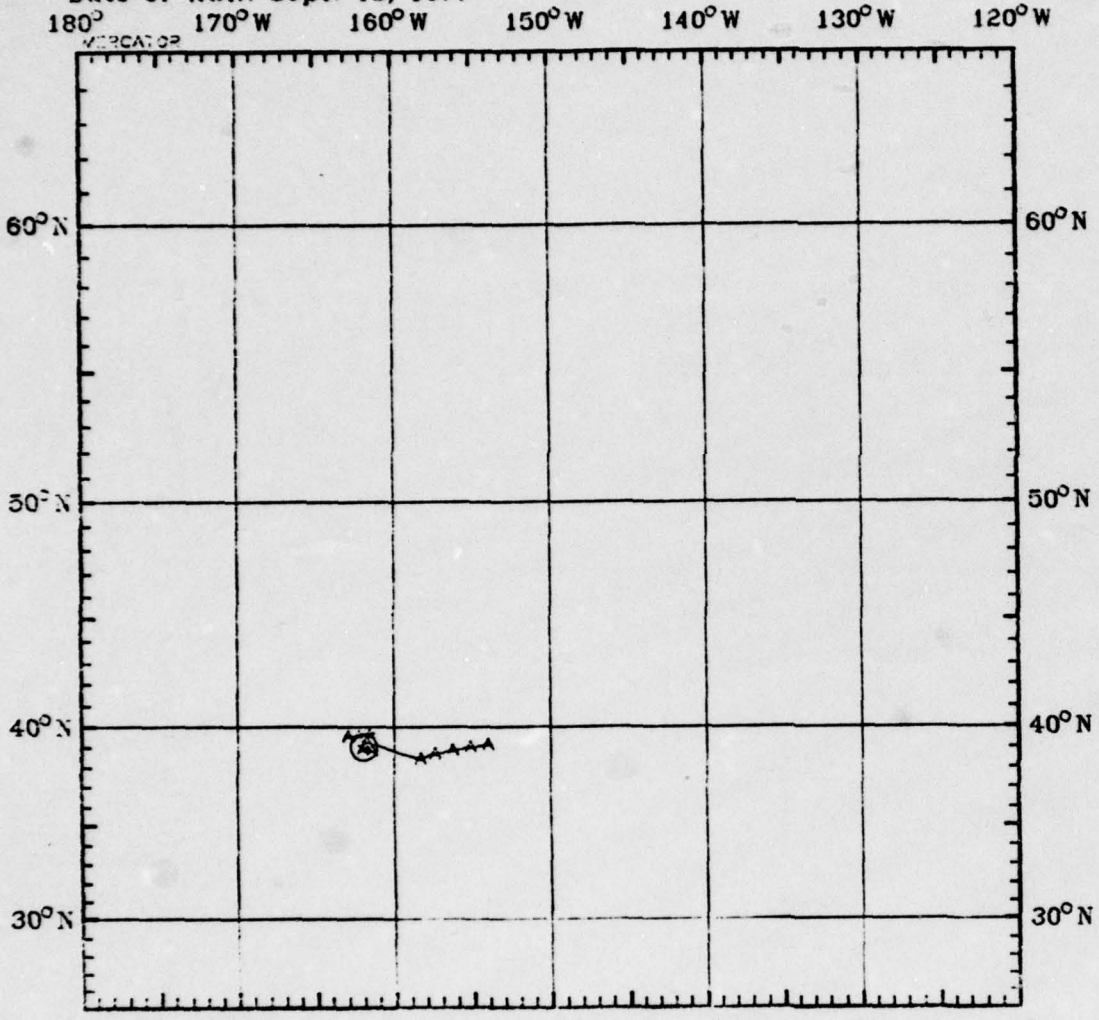
Date of Run: Feb. 6, 1978



Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

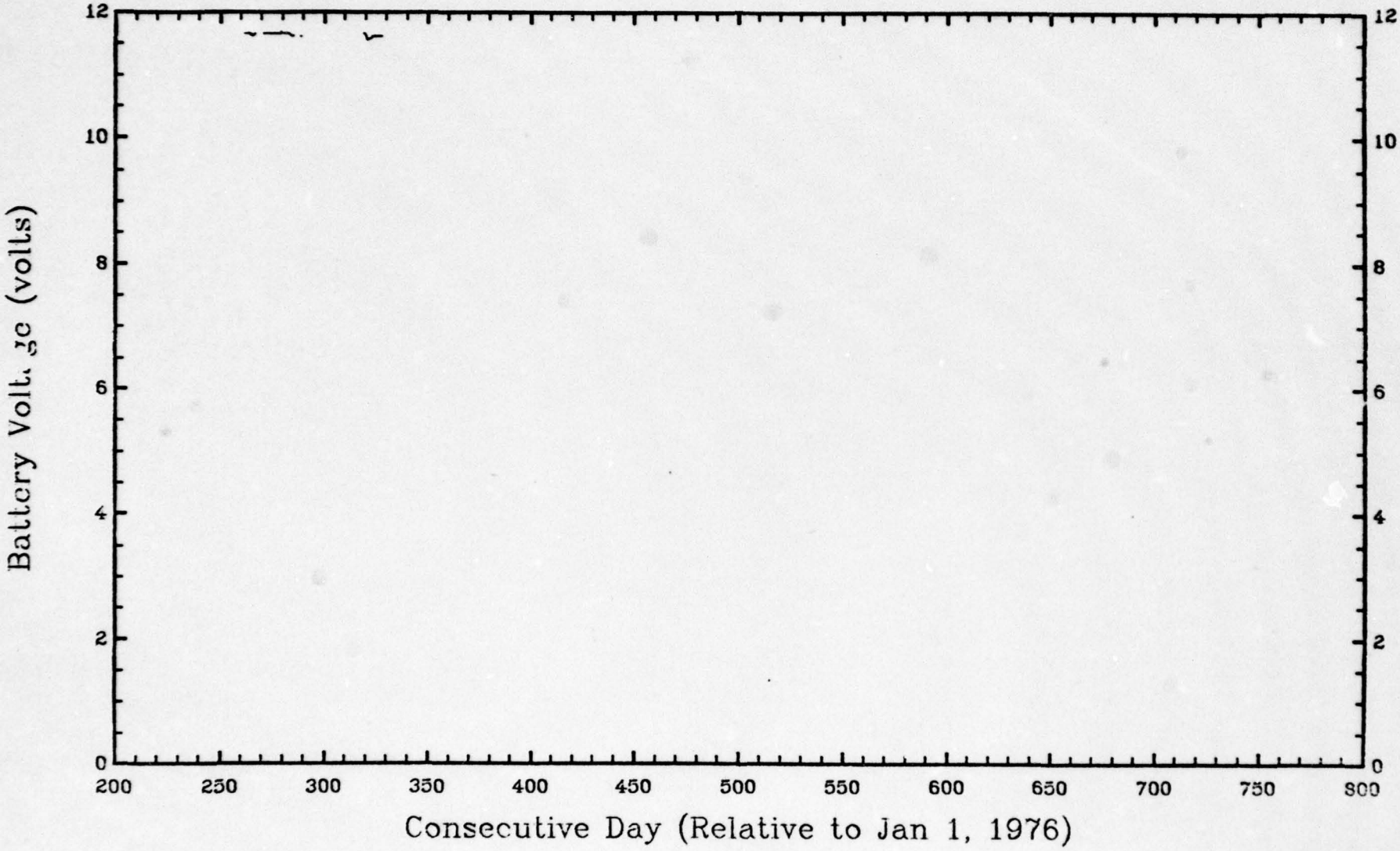
Symbol	Drifter Id
^	1001



Drifter Trajectories
Velocity Checked Positions

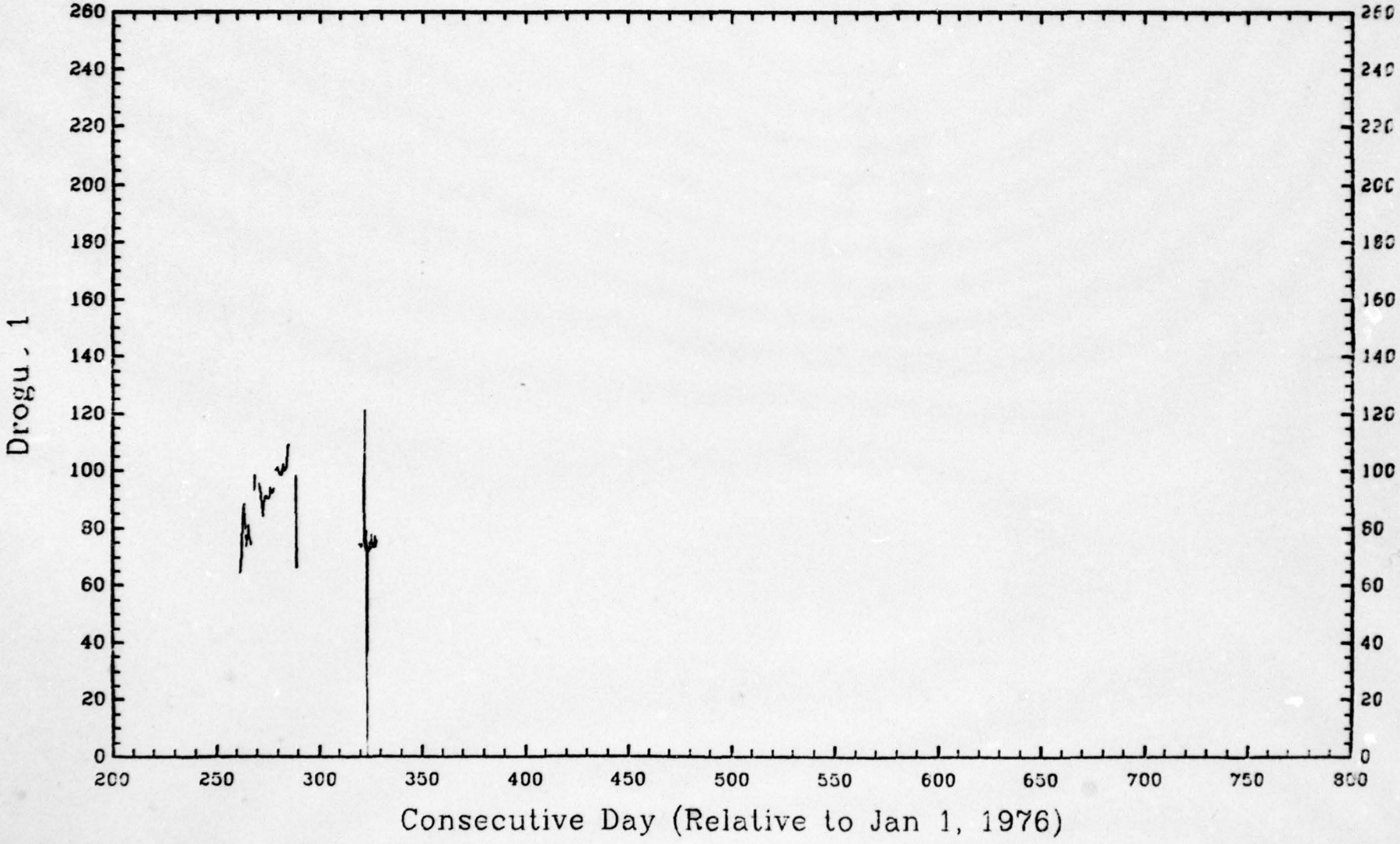
Drifter Id: 1001

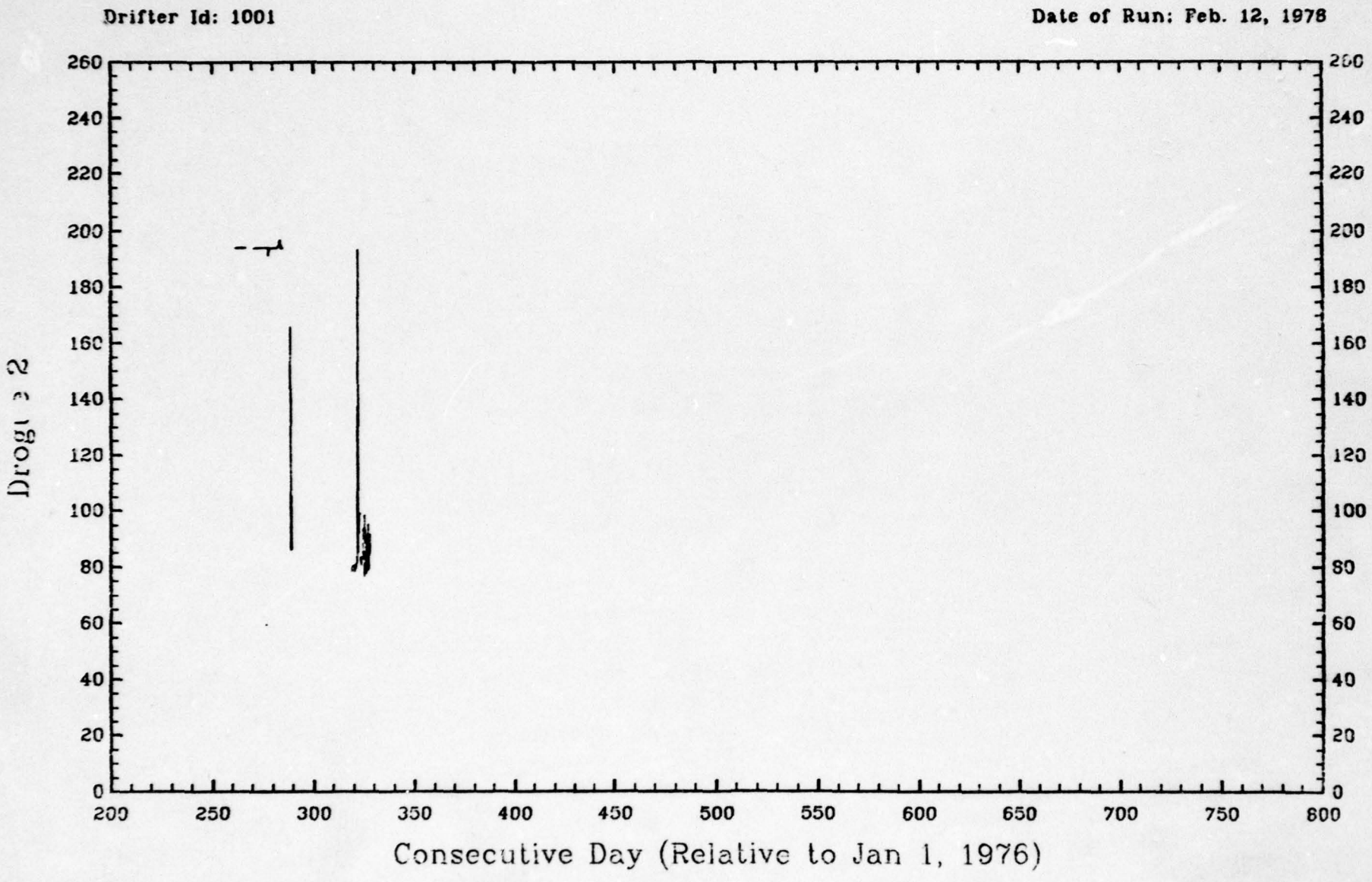
Date of Run: Feb. 6, 1978

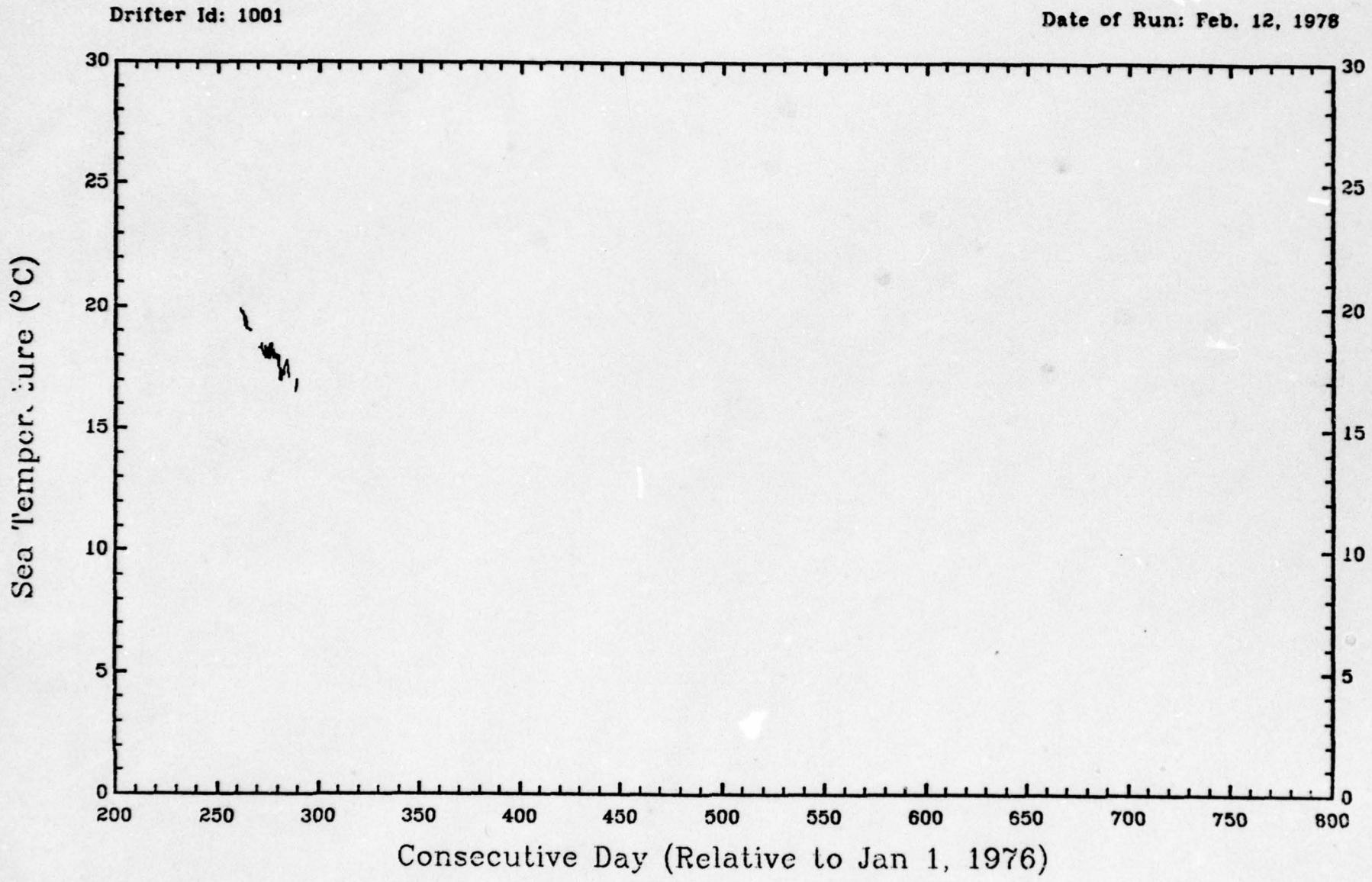


Drifter Id: 1001

Date of Run: Feb. 6, 1978

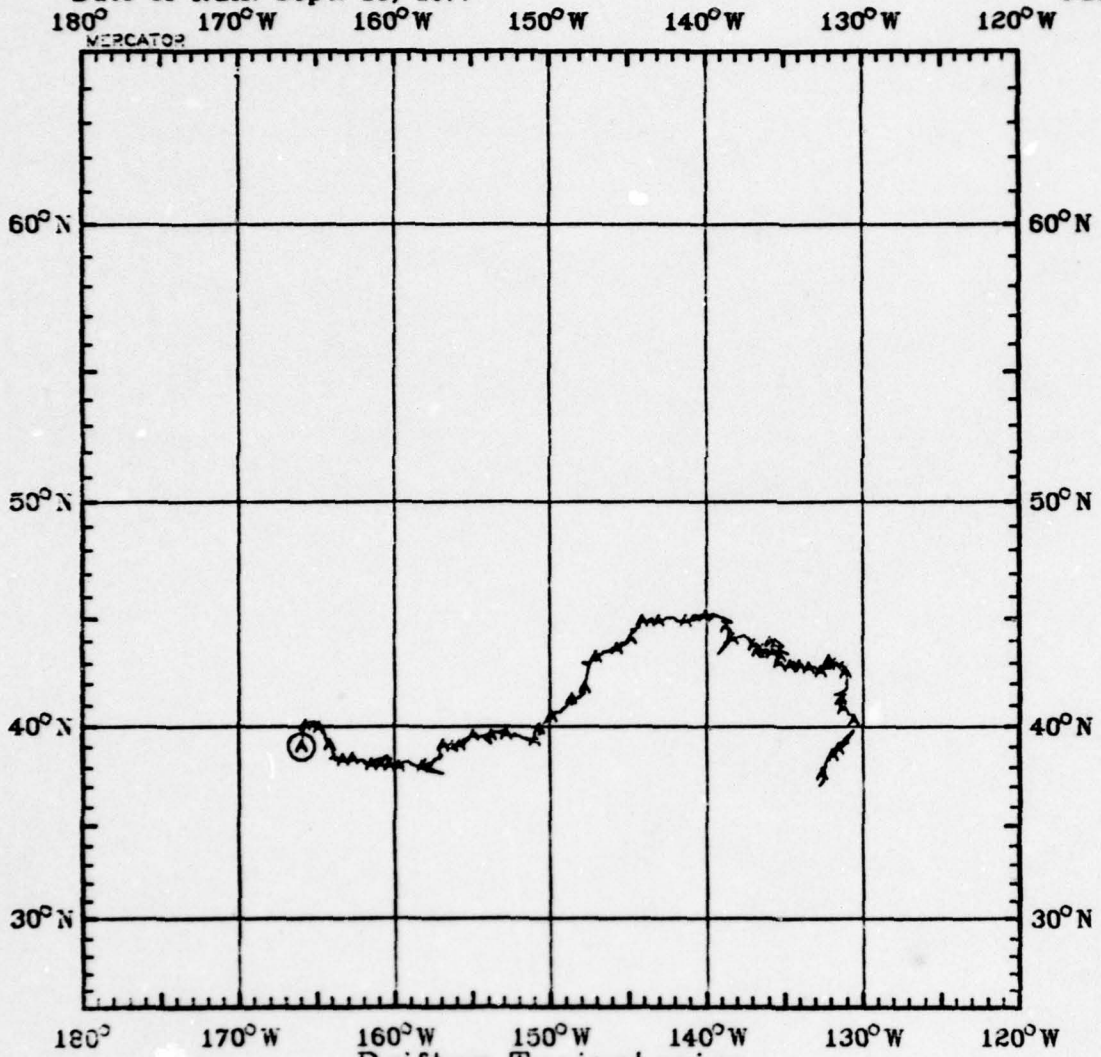



Drifter Id: 1001
Date of Run: Feb. 12, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1001
Date of Run: Feb. 12, 1976
Sea Temperature (°C)
30
25
20
15
10
5
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

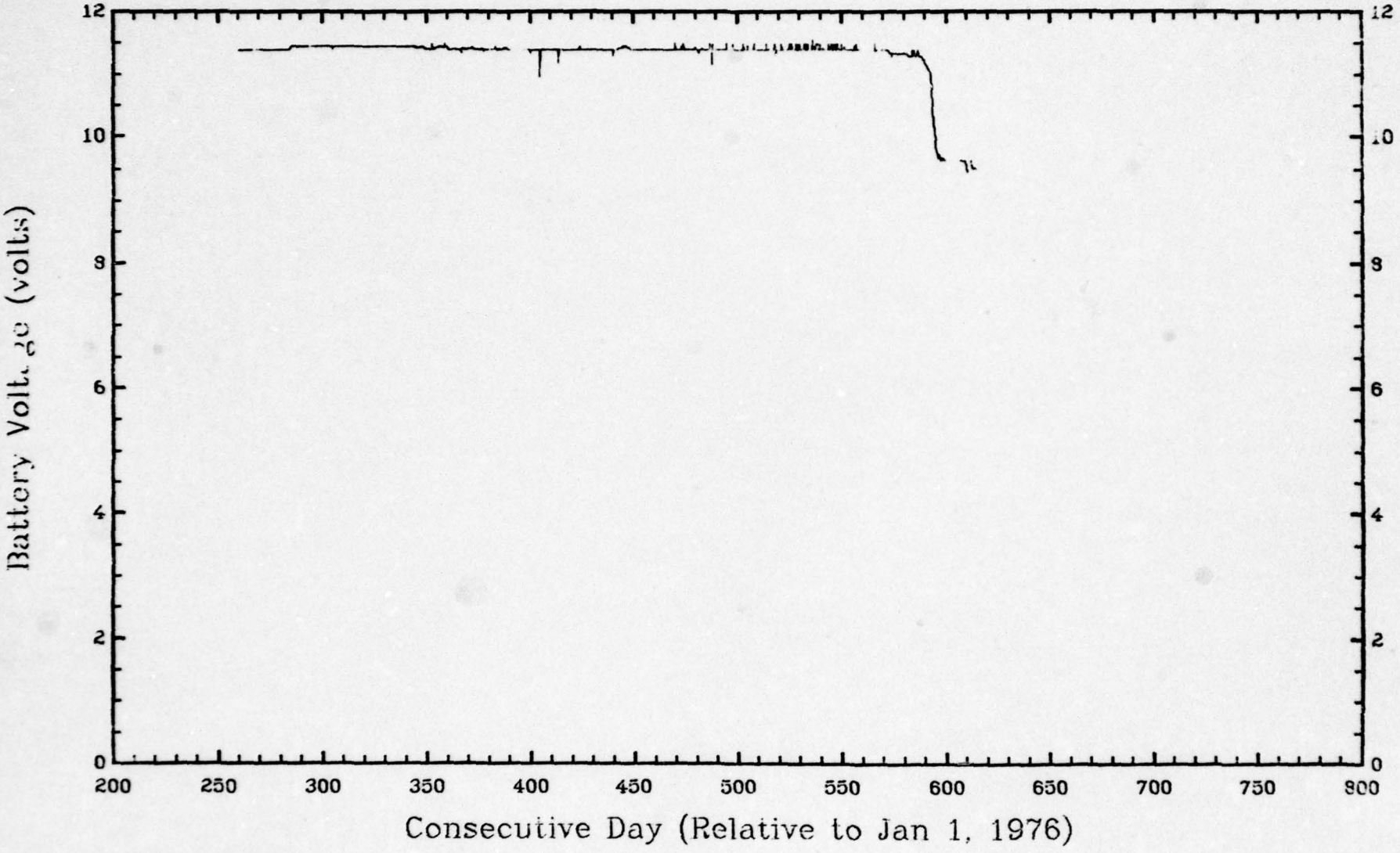


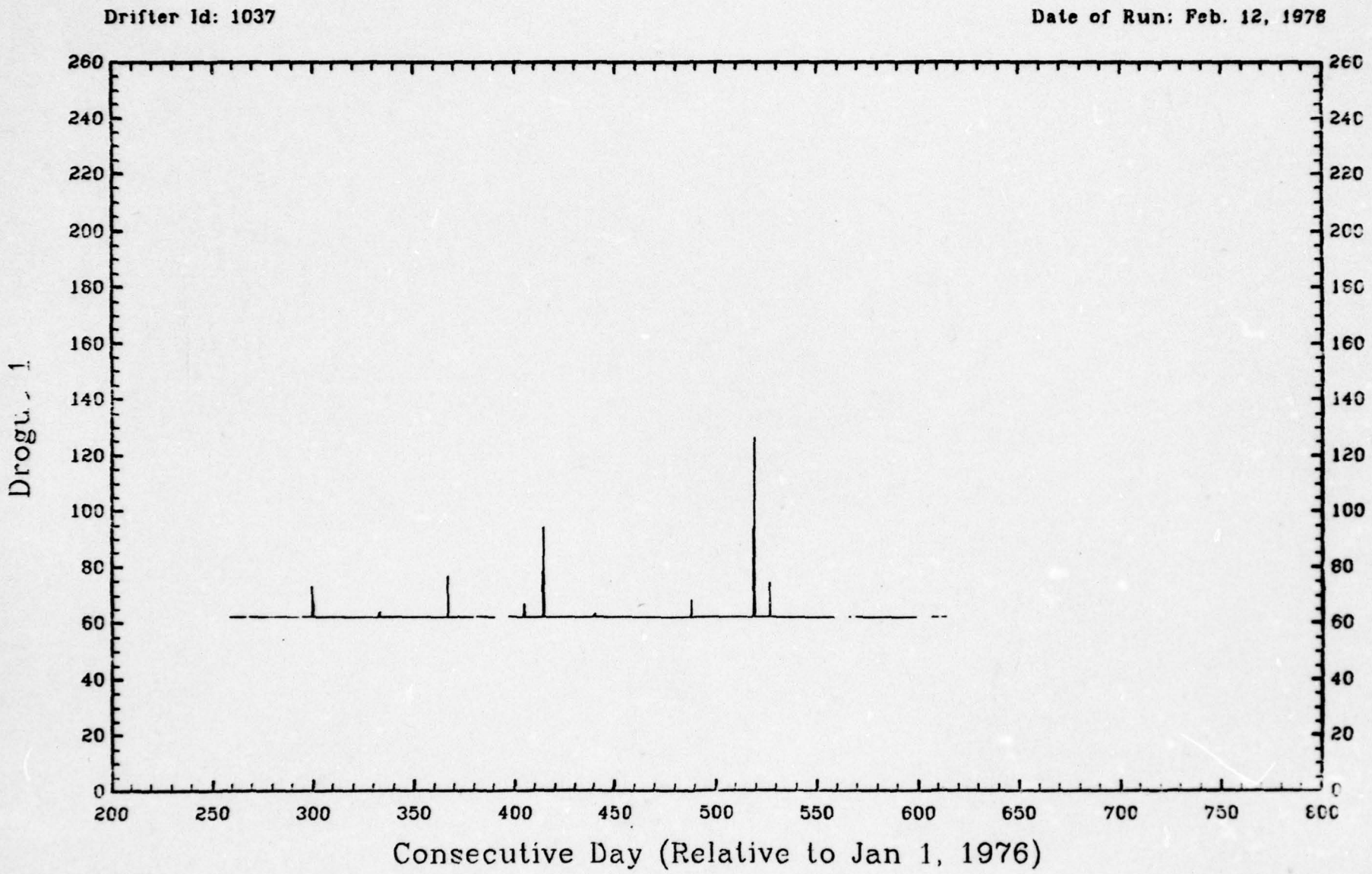
Symbol	Drifter Id
A	1037

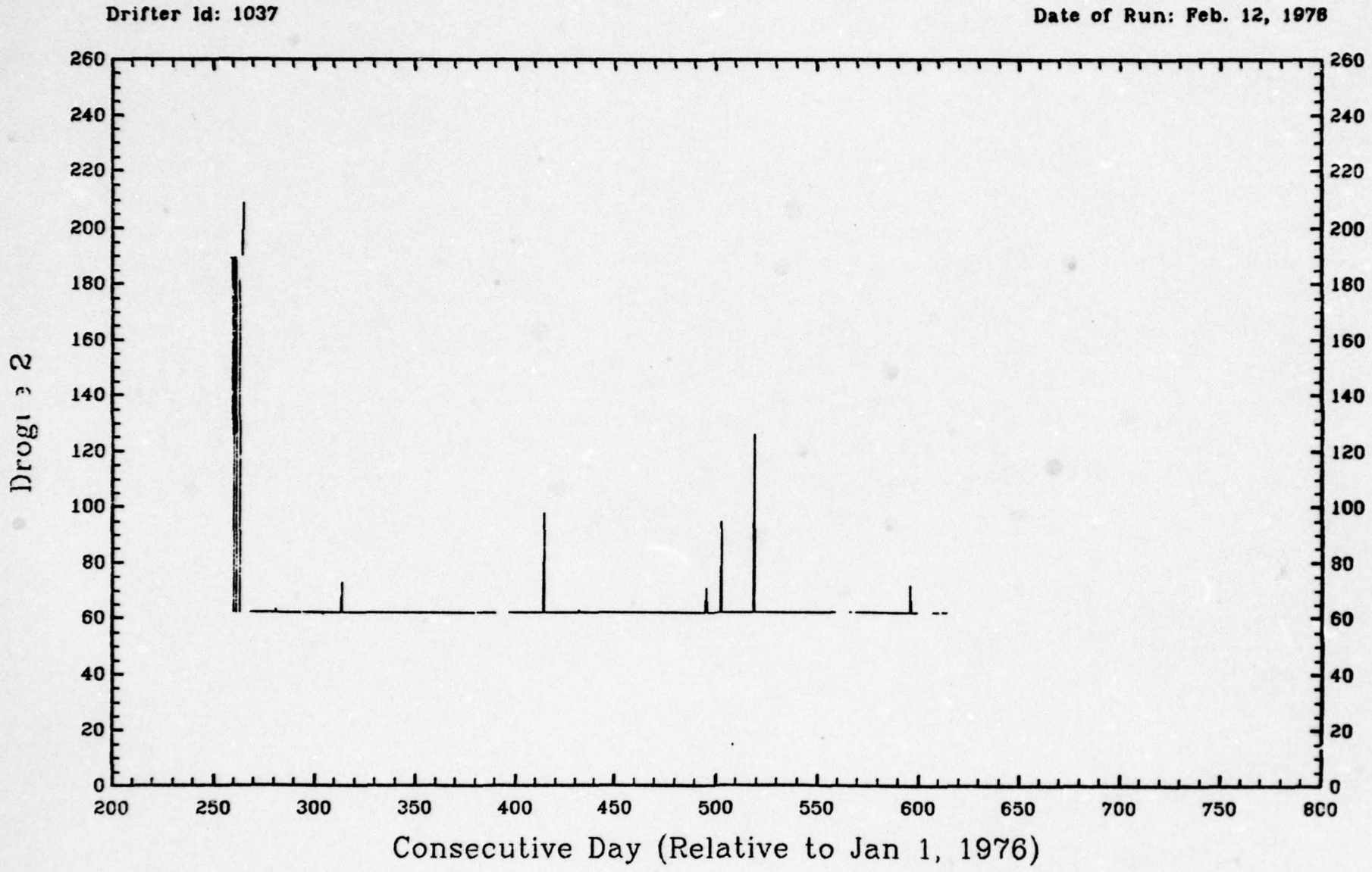
Drifter Trajectories
Velocity Checked Positions

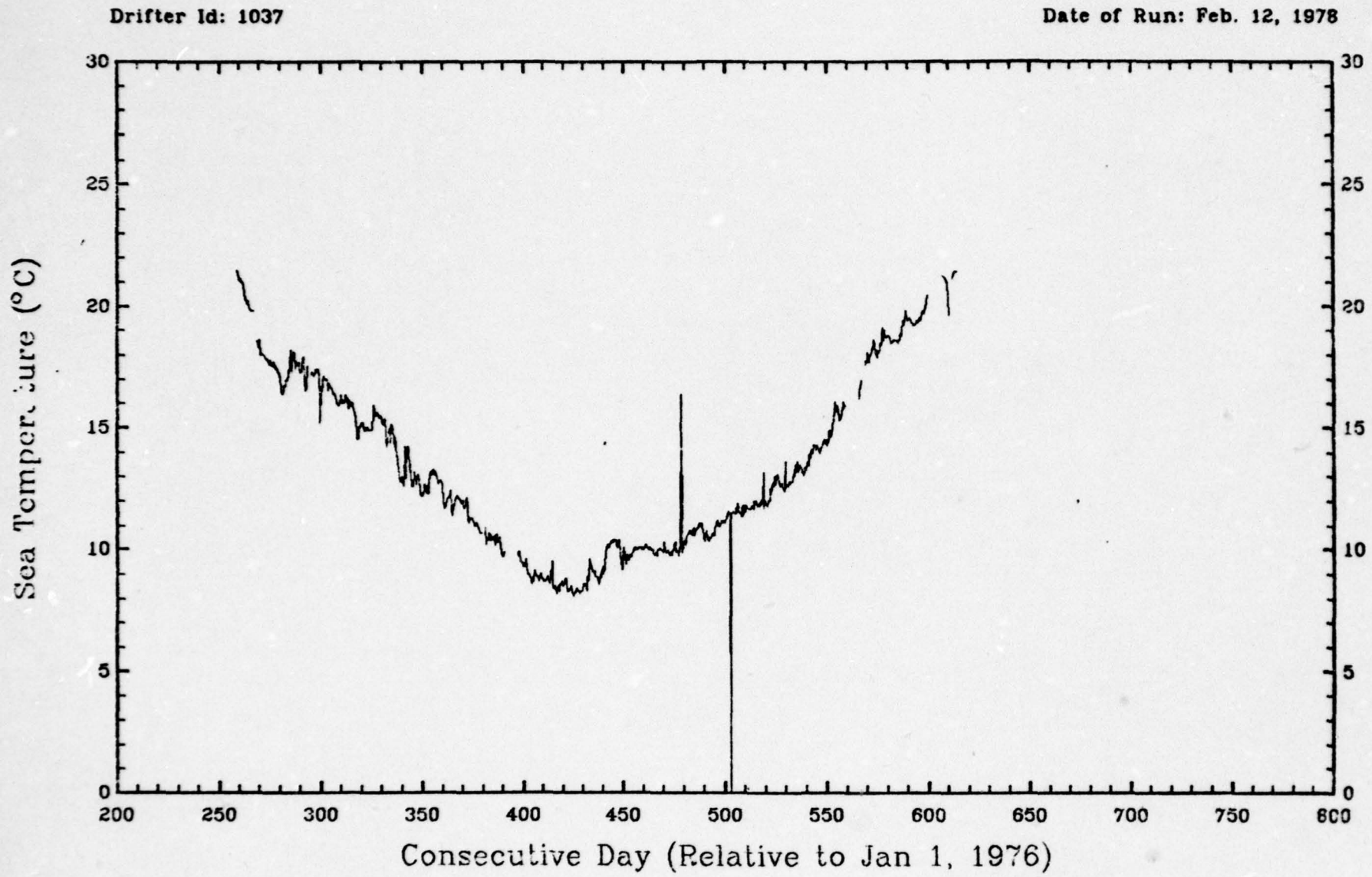
Drifter Id: 1037

Date of Run: Feb. 6, 1978



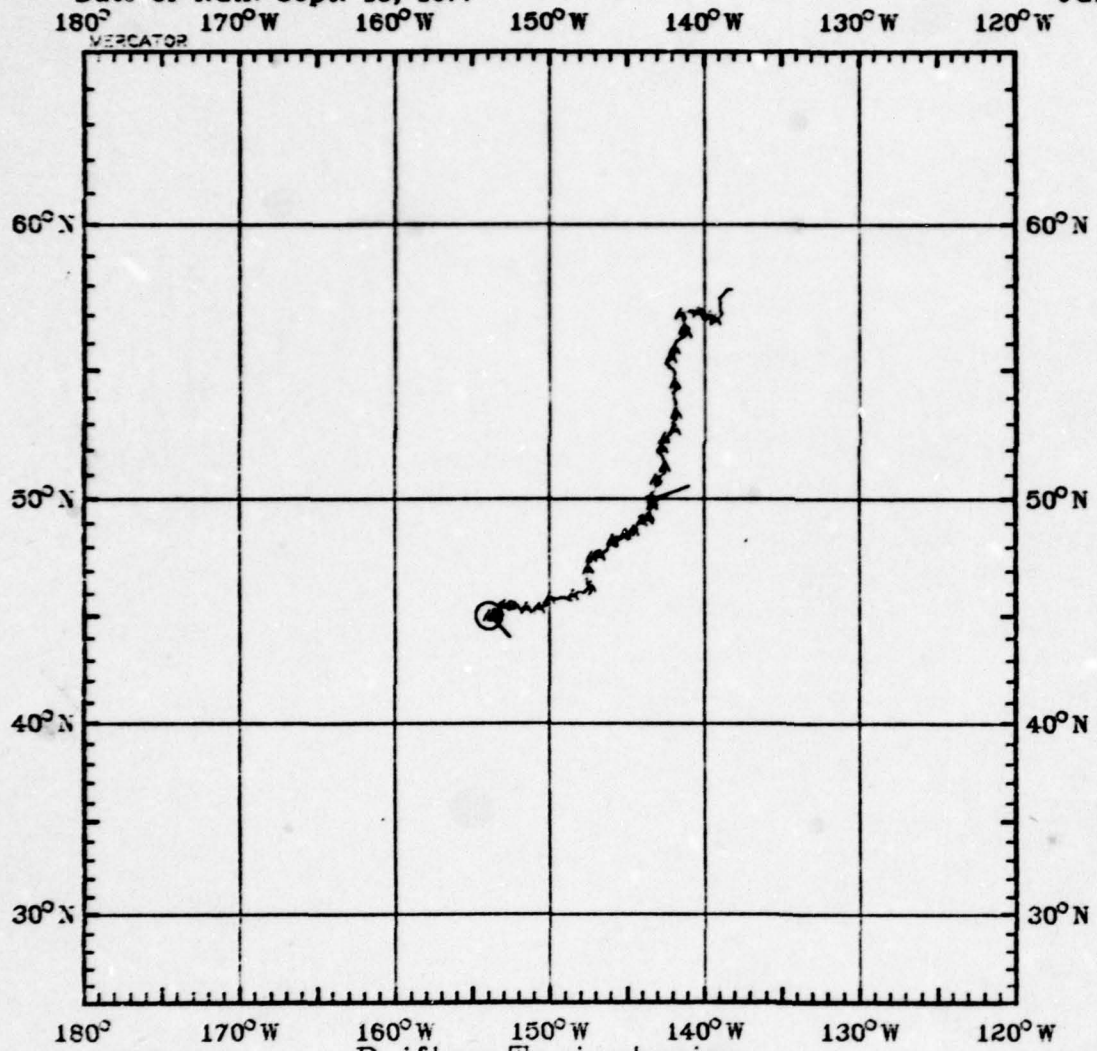

Drifter Id: 1037
Date of Run: Feb. 12, 1978
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1037
Date of Run: Feb. 12, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1037
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
0
5
10
15
20
25
30
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

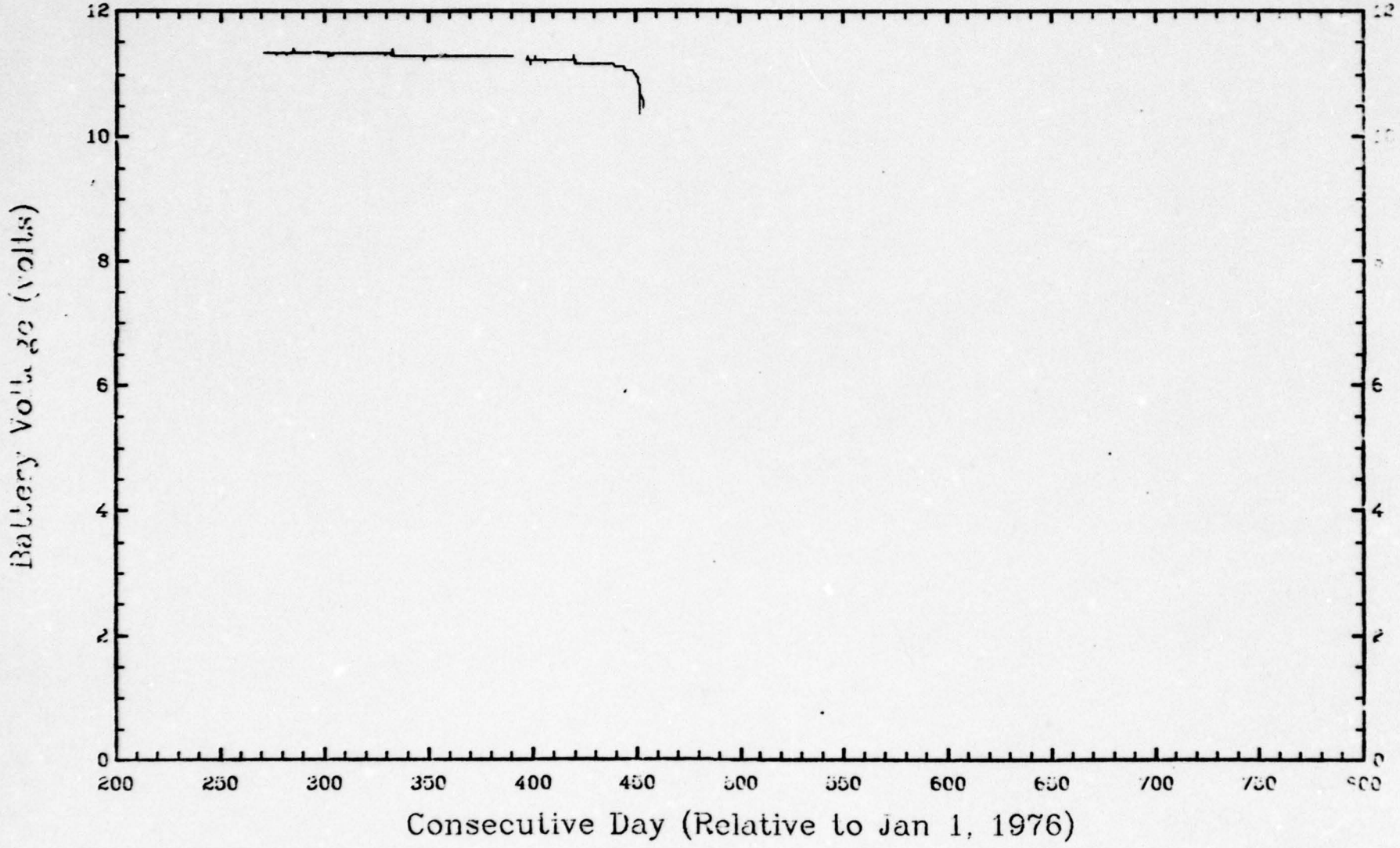


Symbol	Drifter Id
A	1046

Drifter Trajectories
Velocity Checked Positions

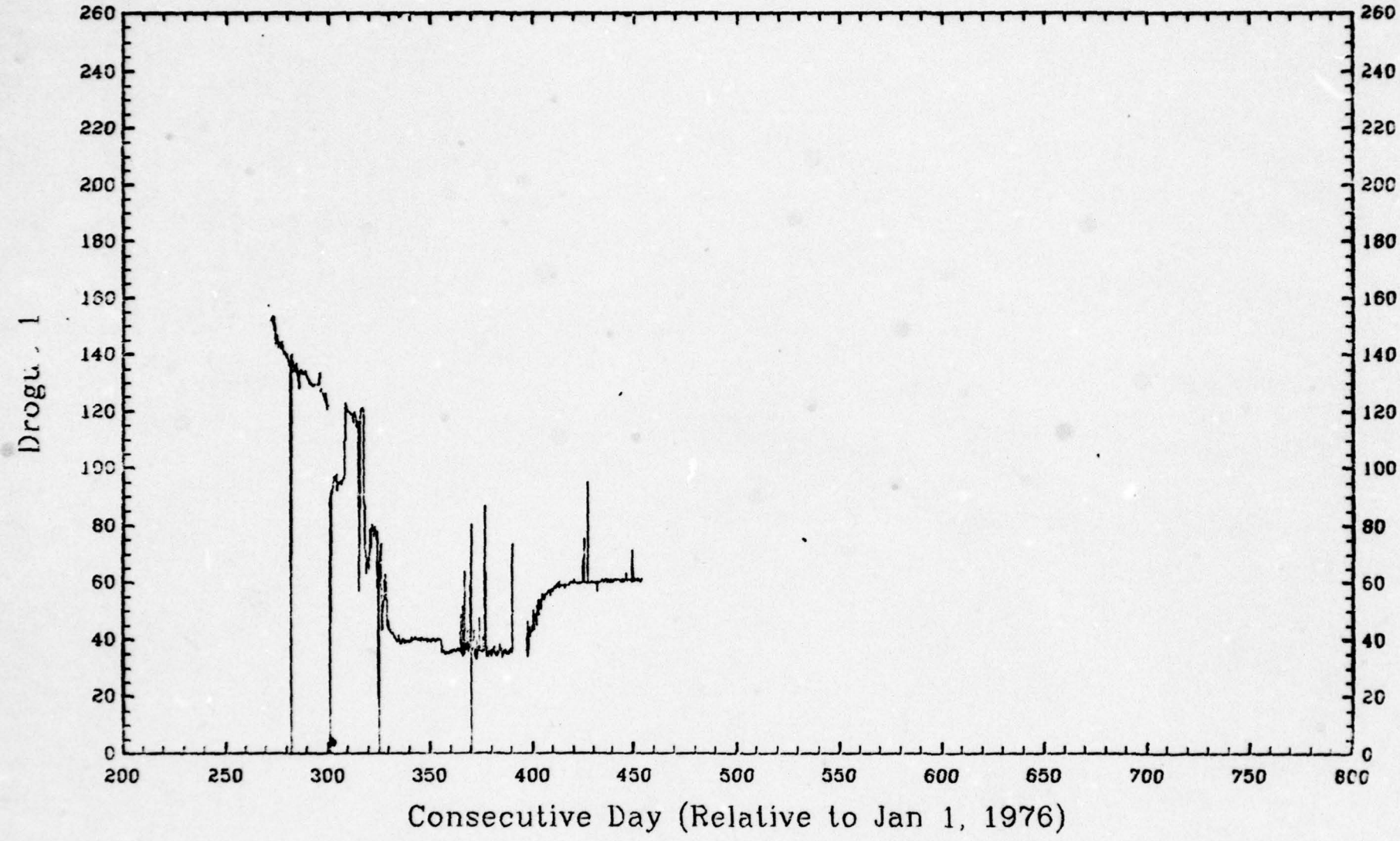
Drifter Id: 1046

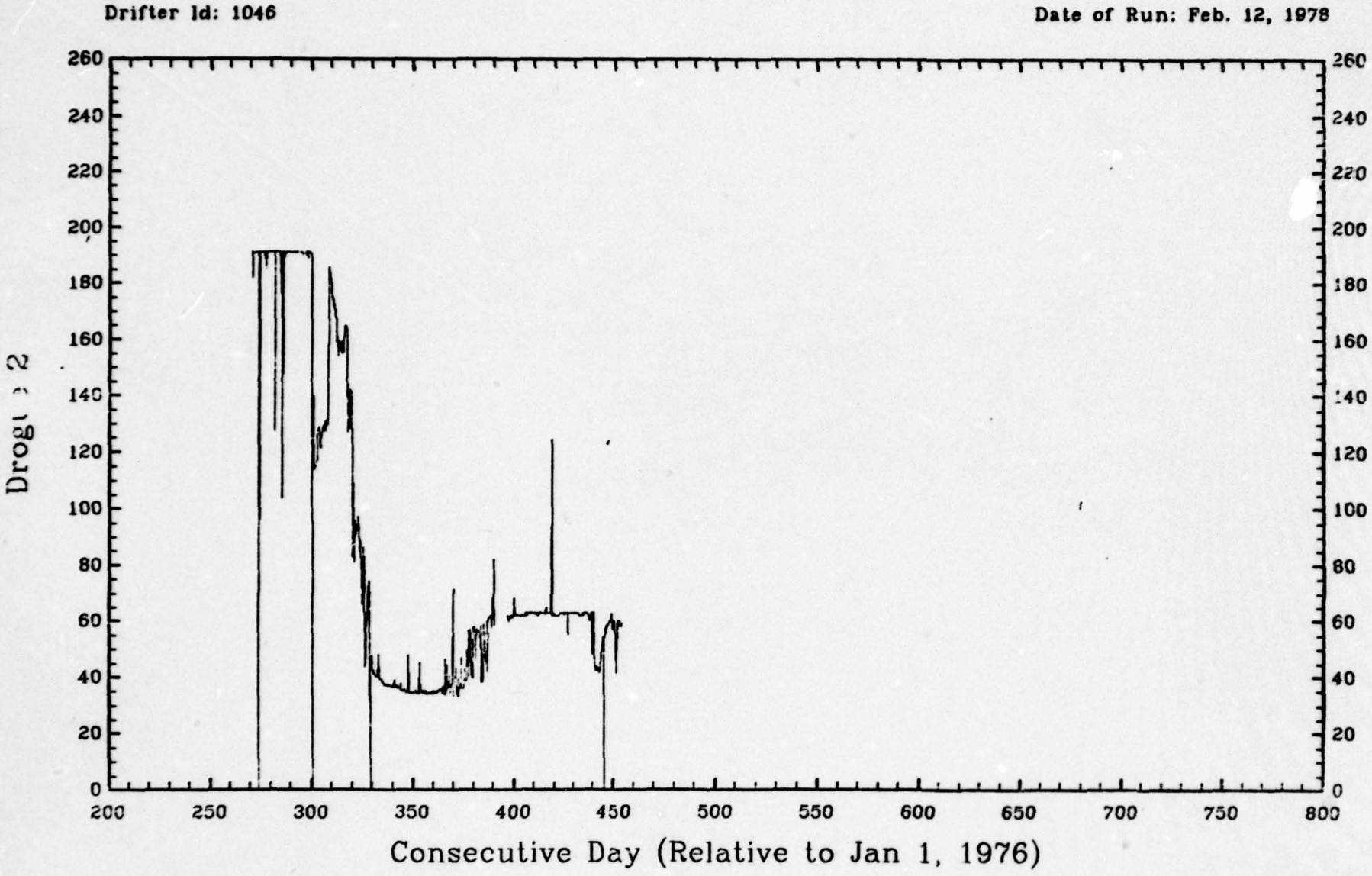
Date of Run: Feb. 6, 1978

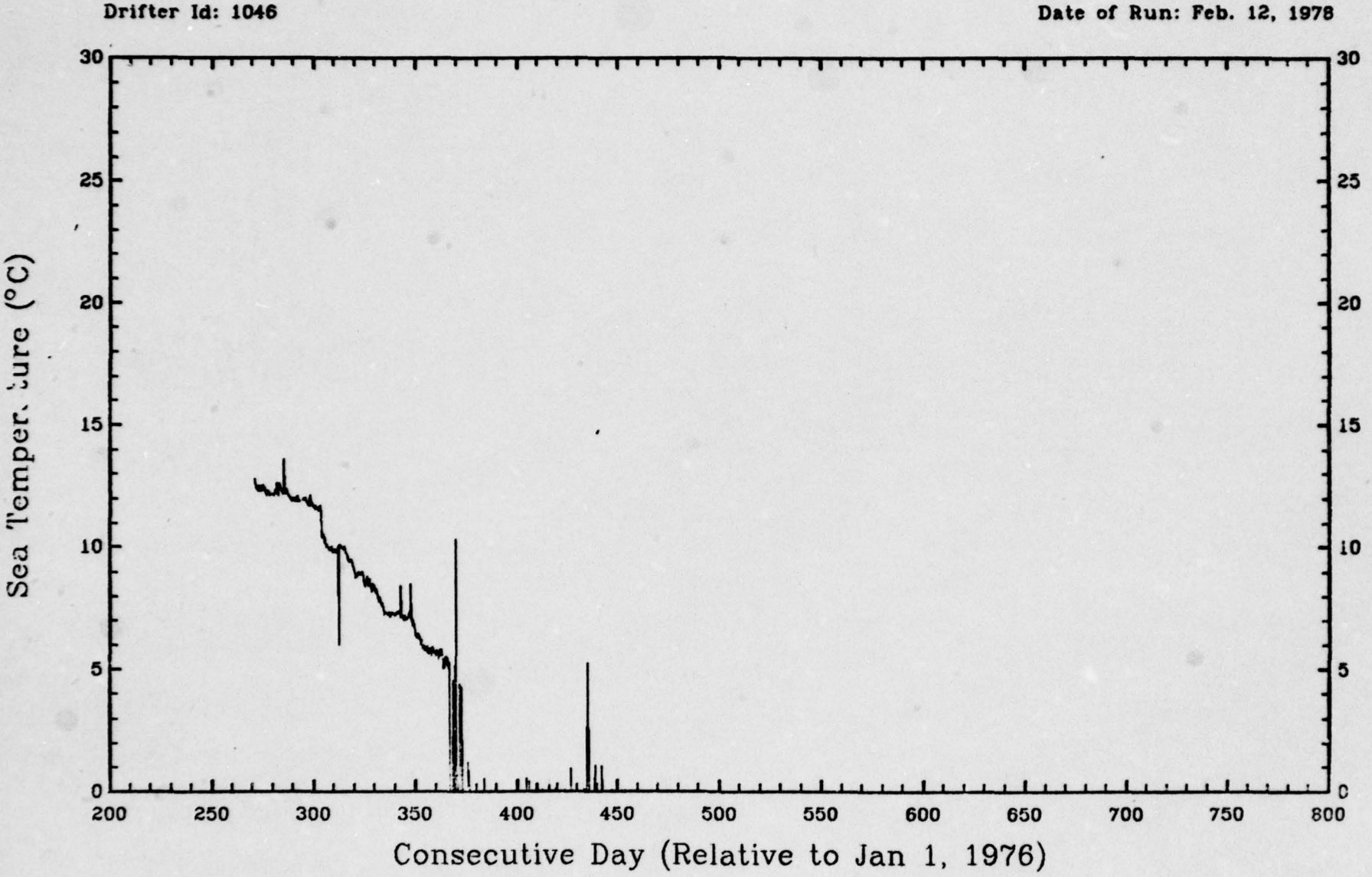


Drifter Id: 1046

Date of Run: Feb. 12, 1976

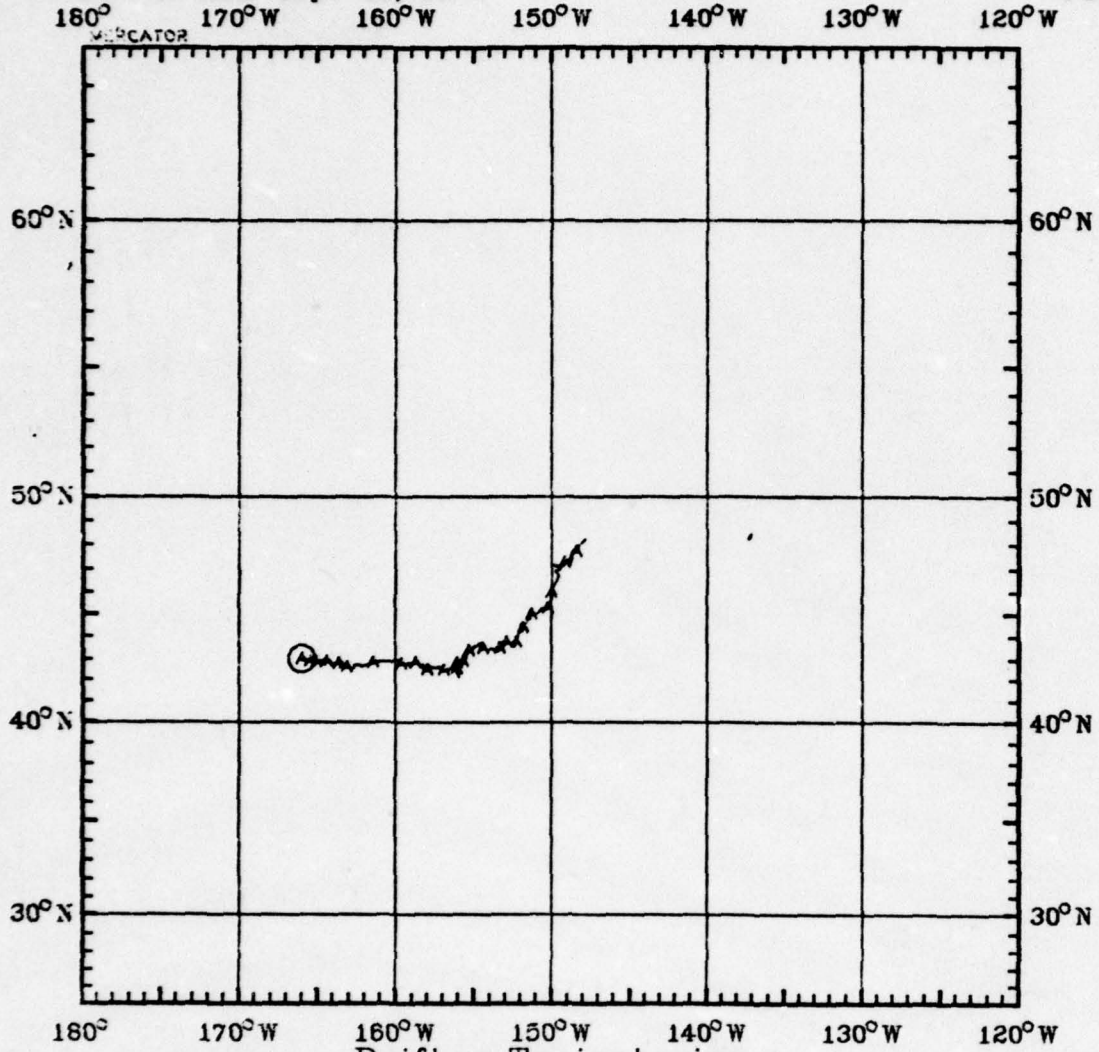



Drifter Id: 1046
Date of Run: Feb. 12, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1046
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
30
25
20
15
10
5
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

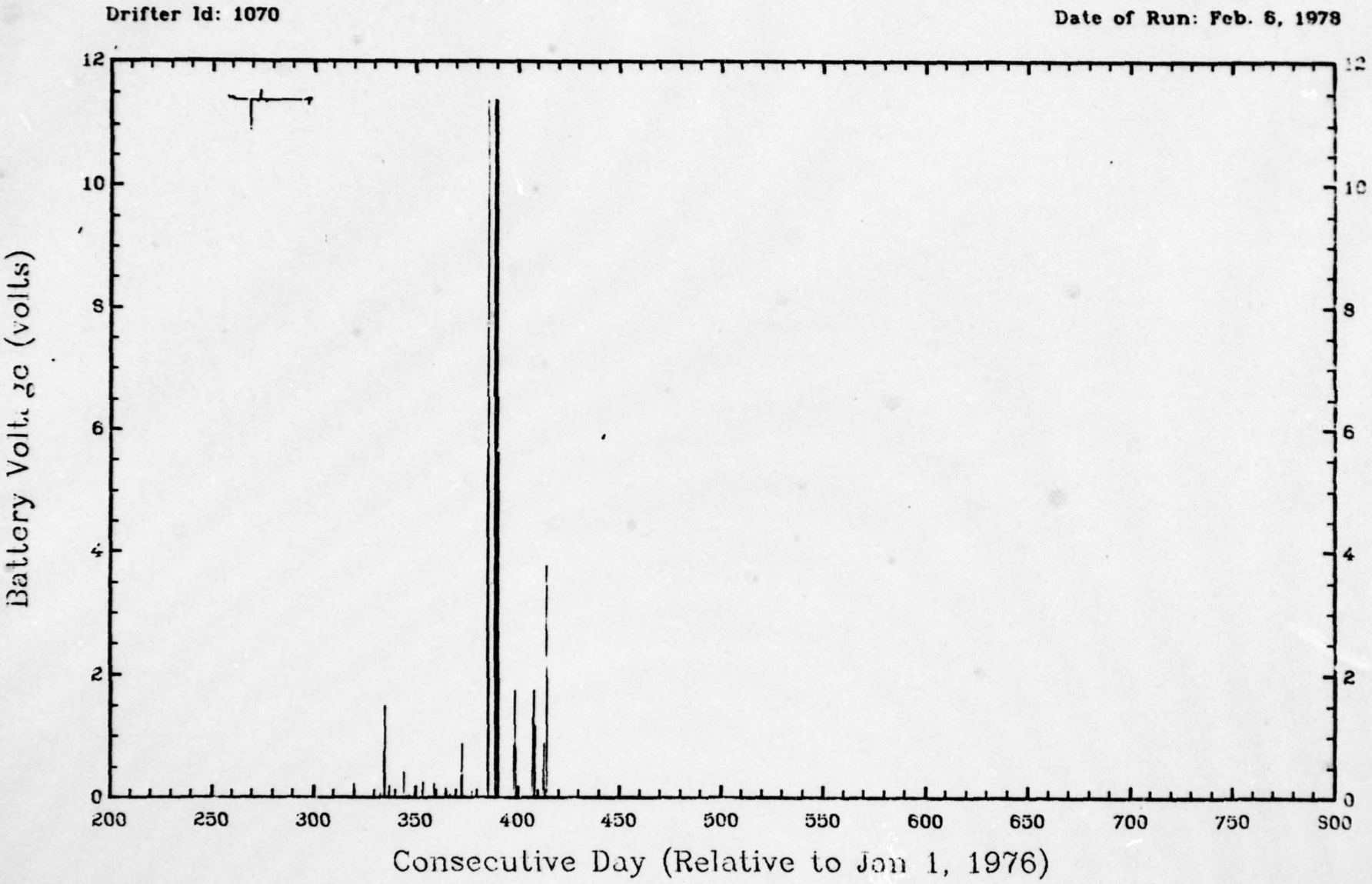
Date of Run: Sept. 15, 1977

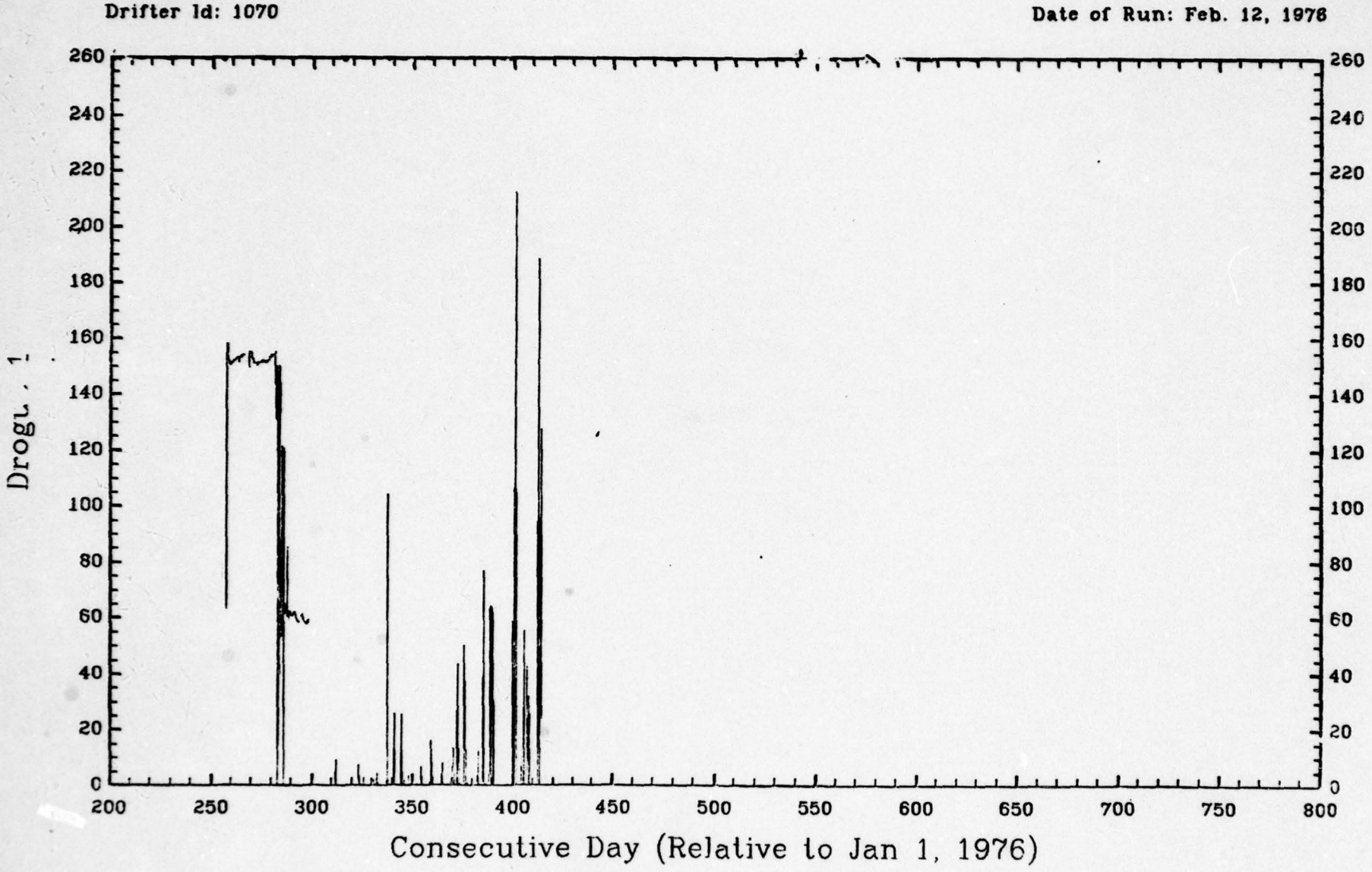
Period Covered:
June 1, 1976 to Sept. 15, 1977



Symbol	Drifter Id
A	1070

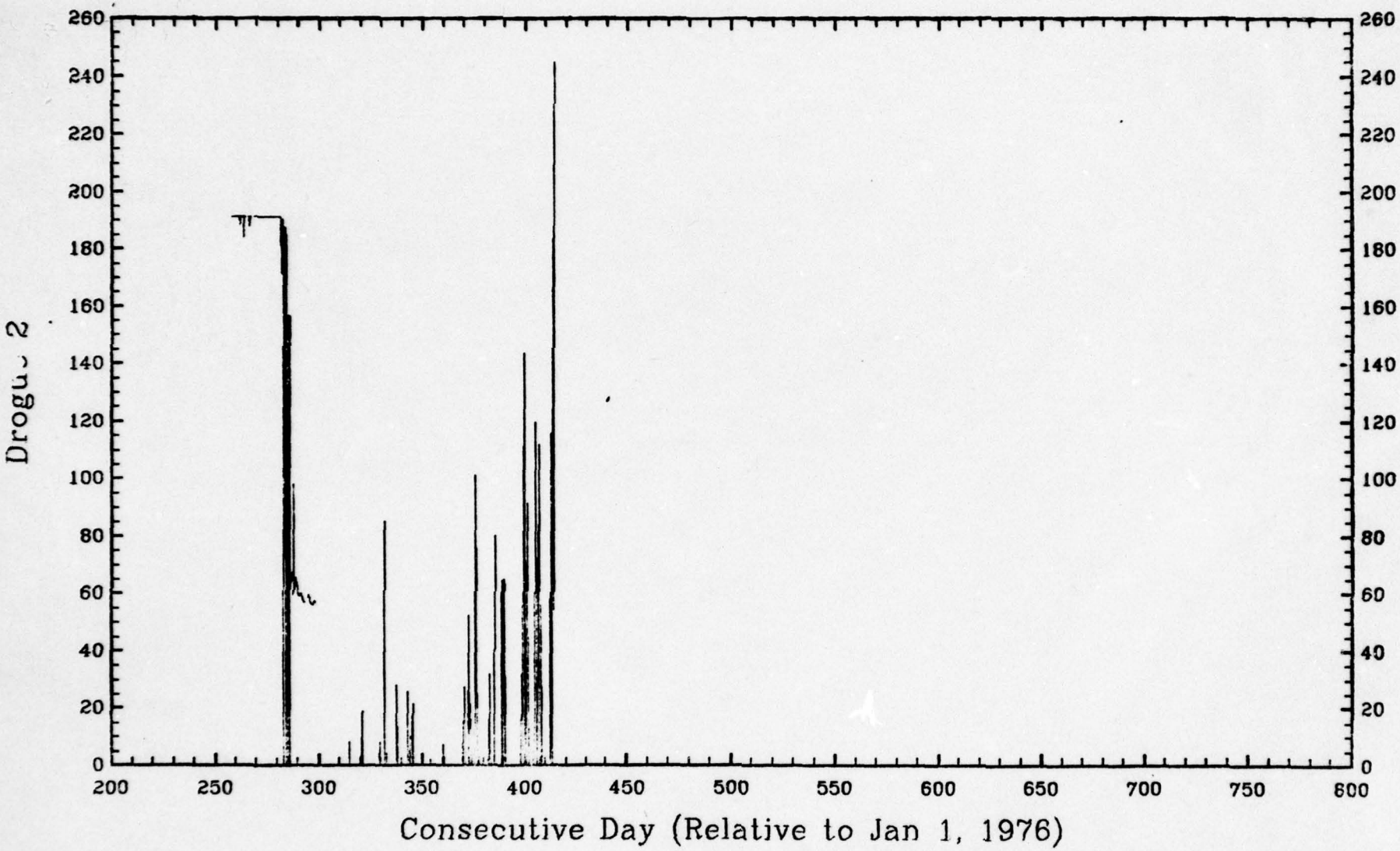
Drifter Trajectories
Velocity Checked Positions

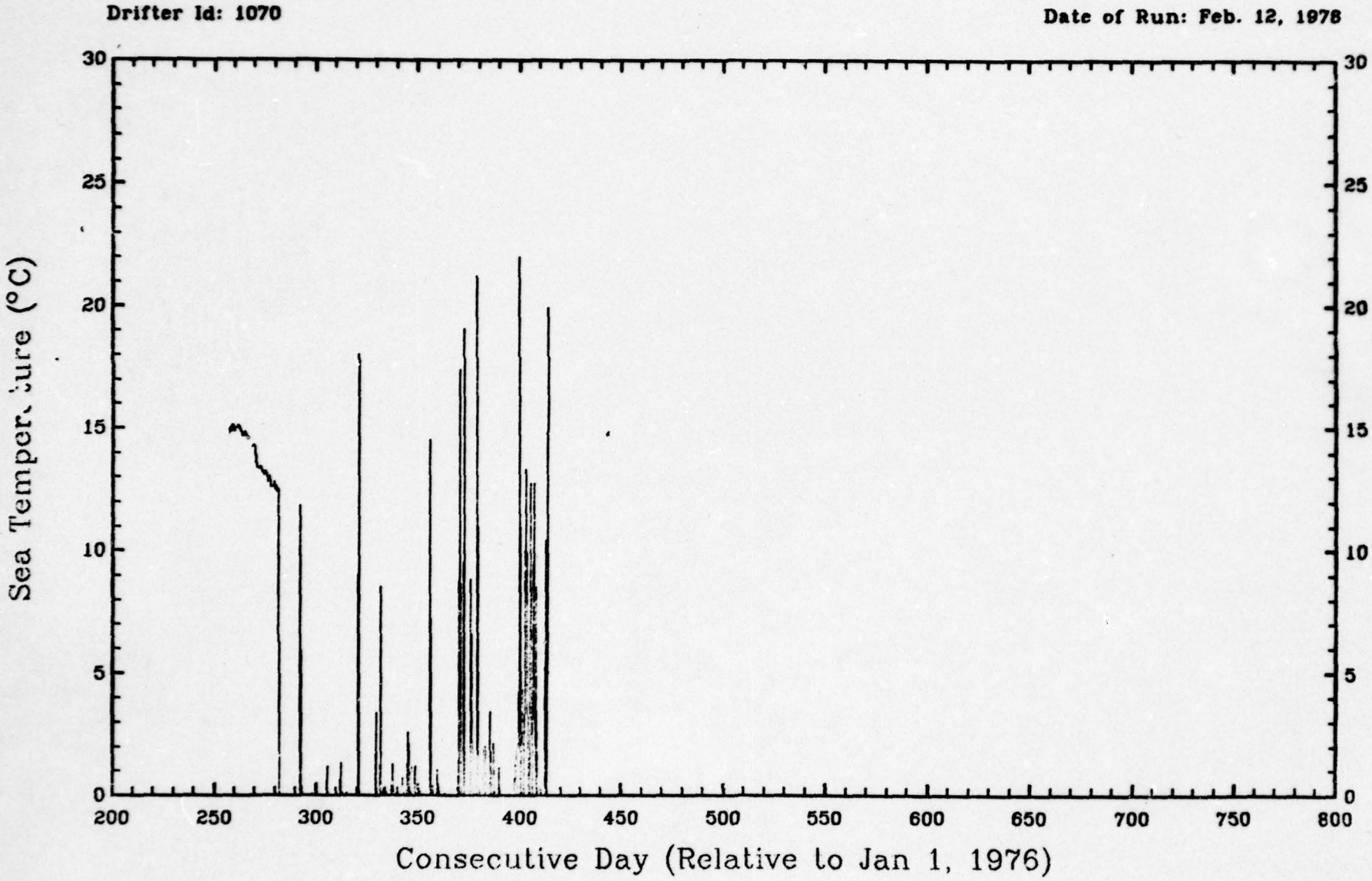

Drifter Id: 1070
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
12
10
8
6
4
2
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1070
Date of Run: Feb. 12, 1976
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1070

Date of Run: Feb. 12, 1978

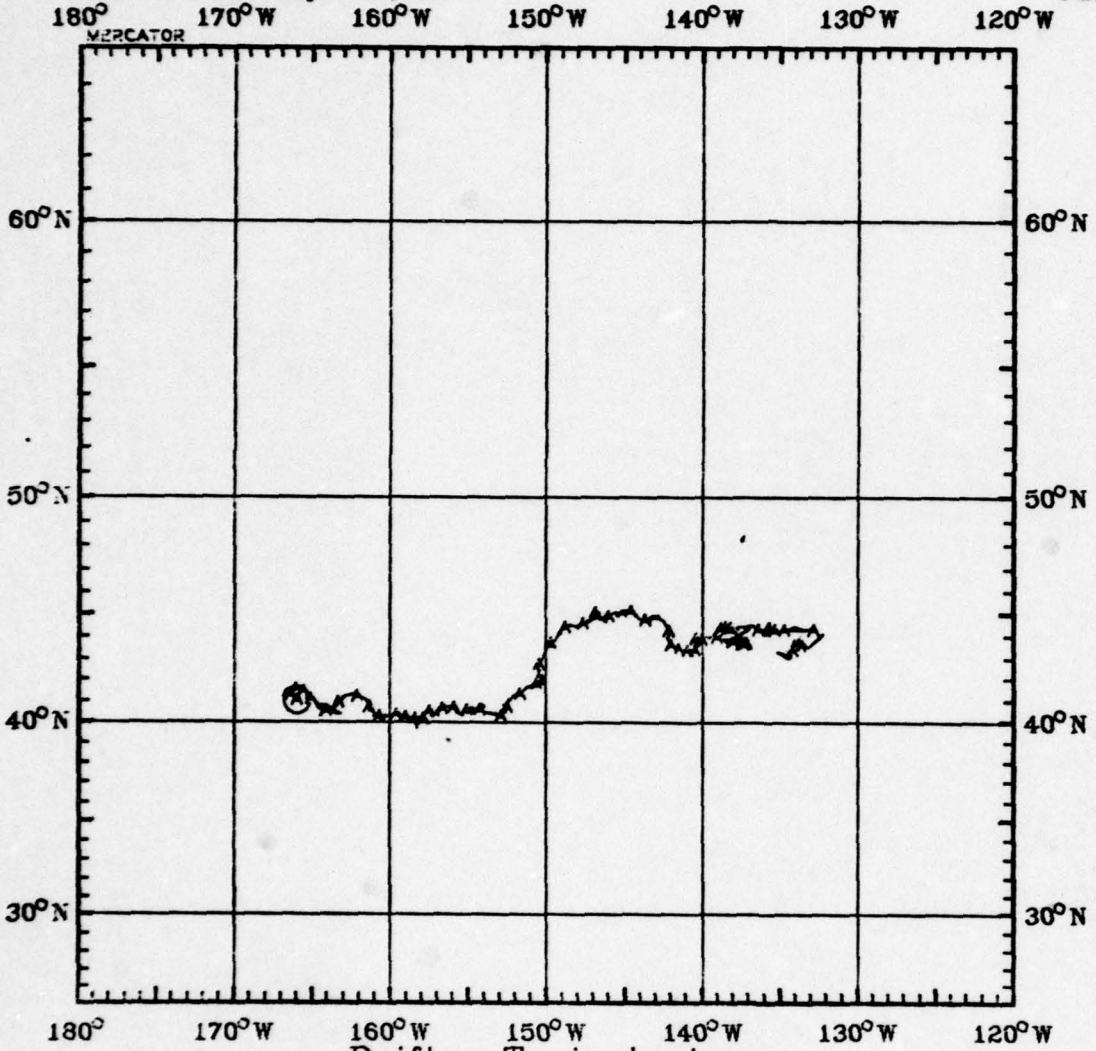



Drifter Id: 1070
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
Consecutive Day (Relative to Jan 1, 1976)
0
5
10
15
20
25
30
200
250
300
350
400
450
500
550
600
650
700
750
800

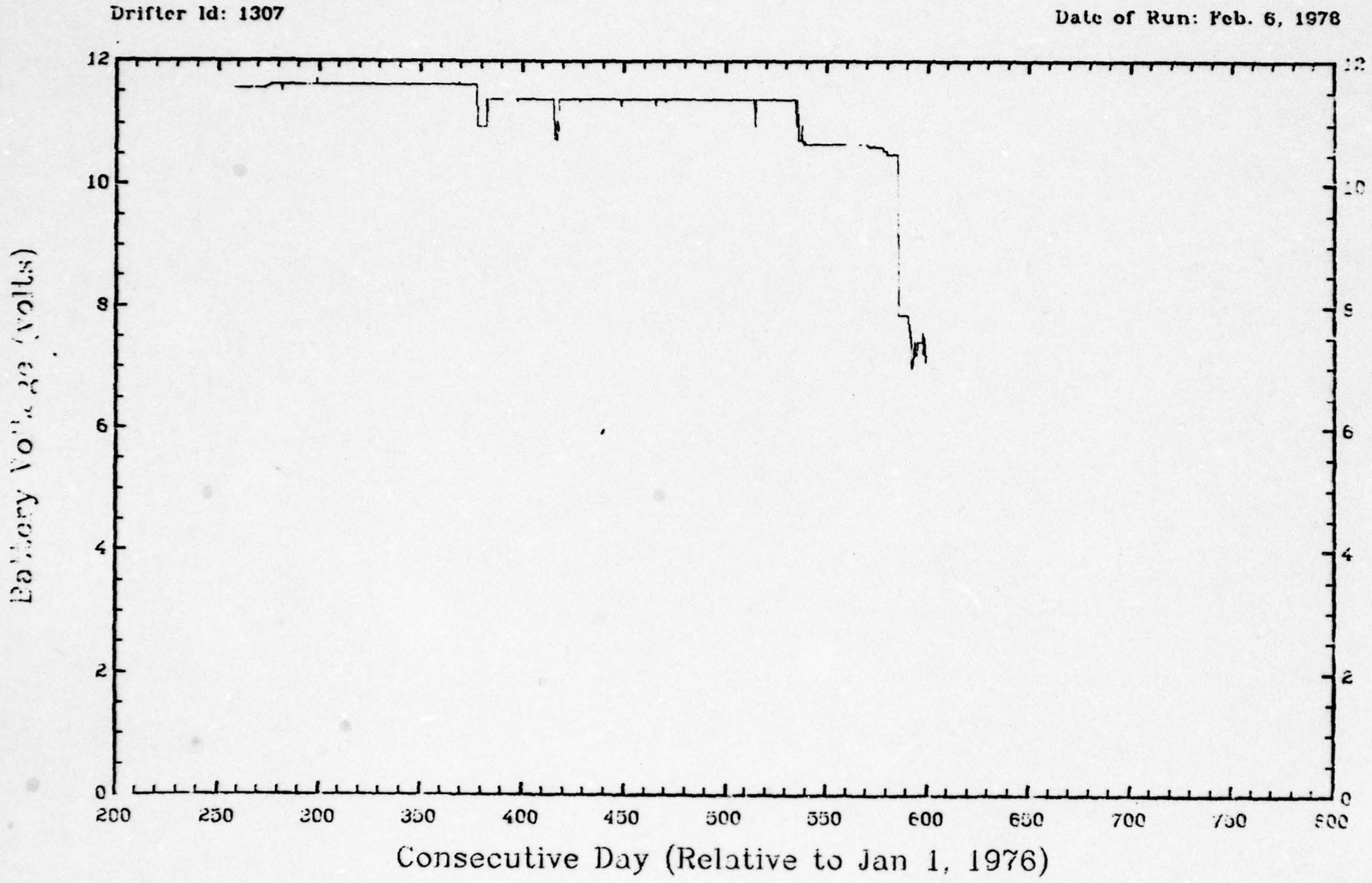
Date of Run: Sept. 15, 1977

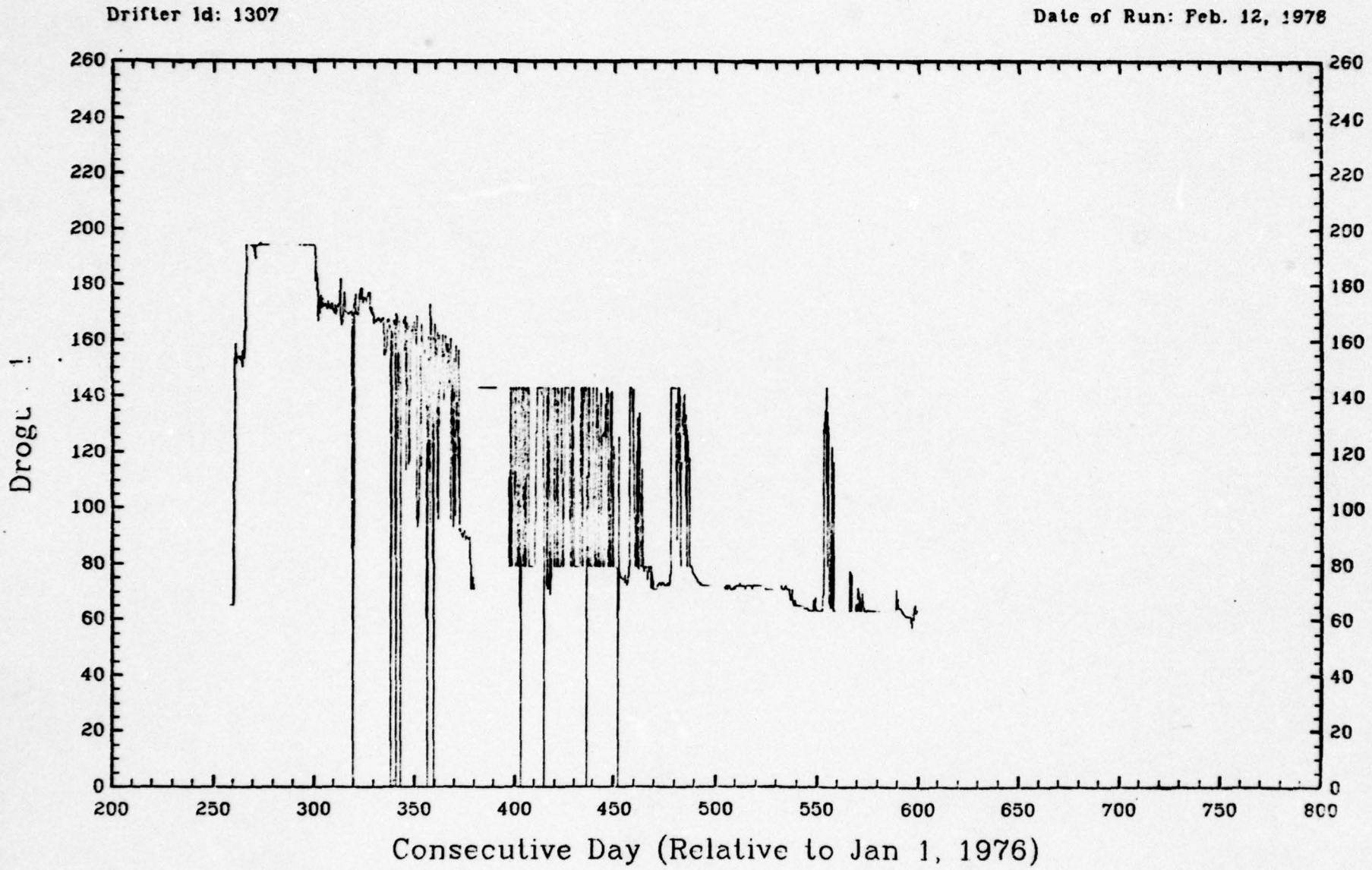
Period Covered:
June 1, 1976 to Sept. 15, 1977

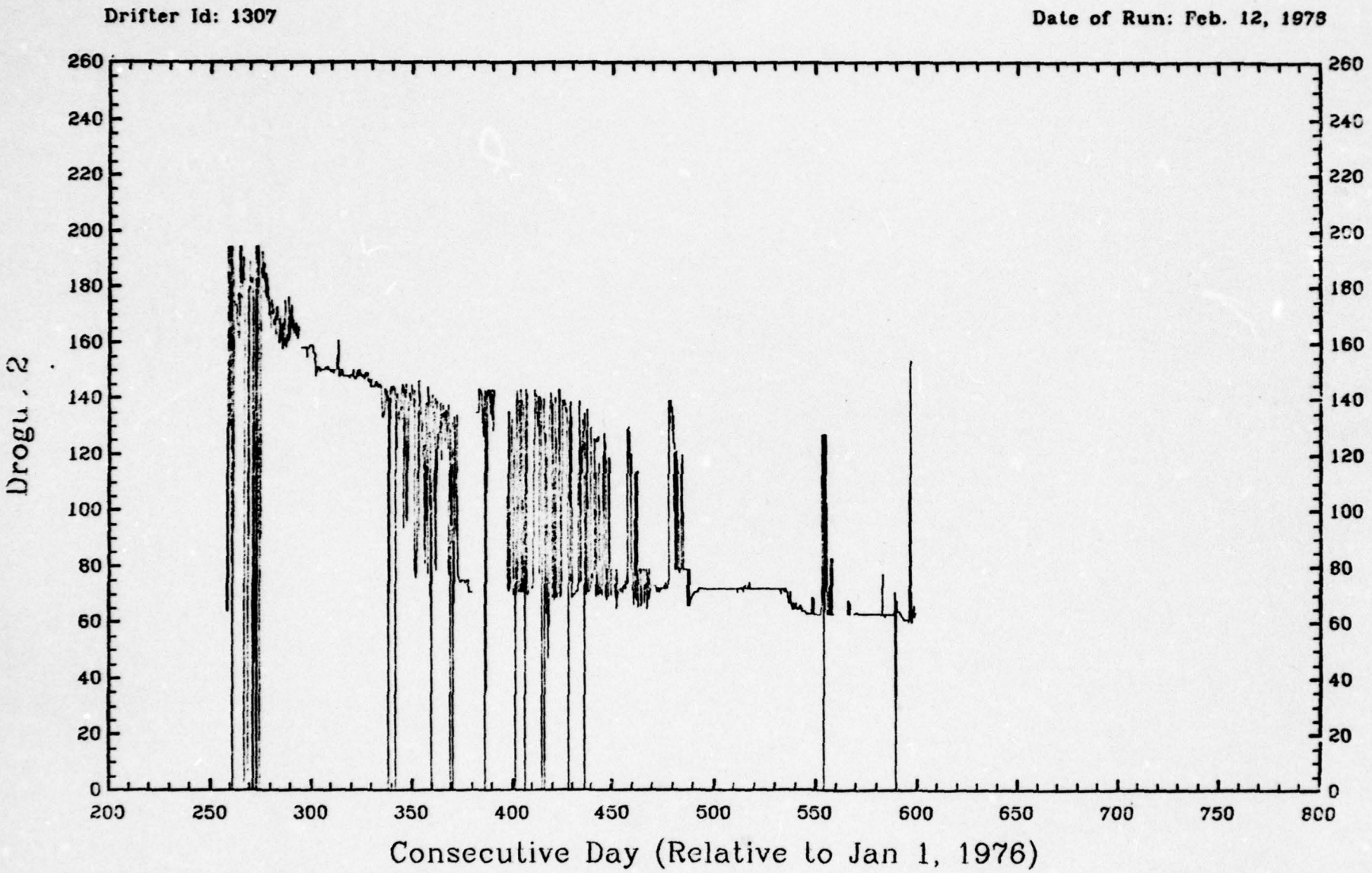
Symbol	Drifter Id
A	1307

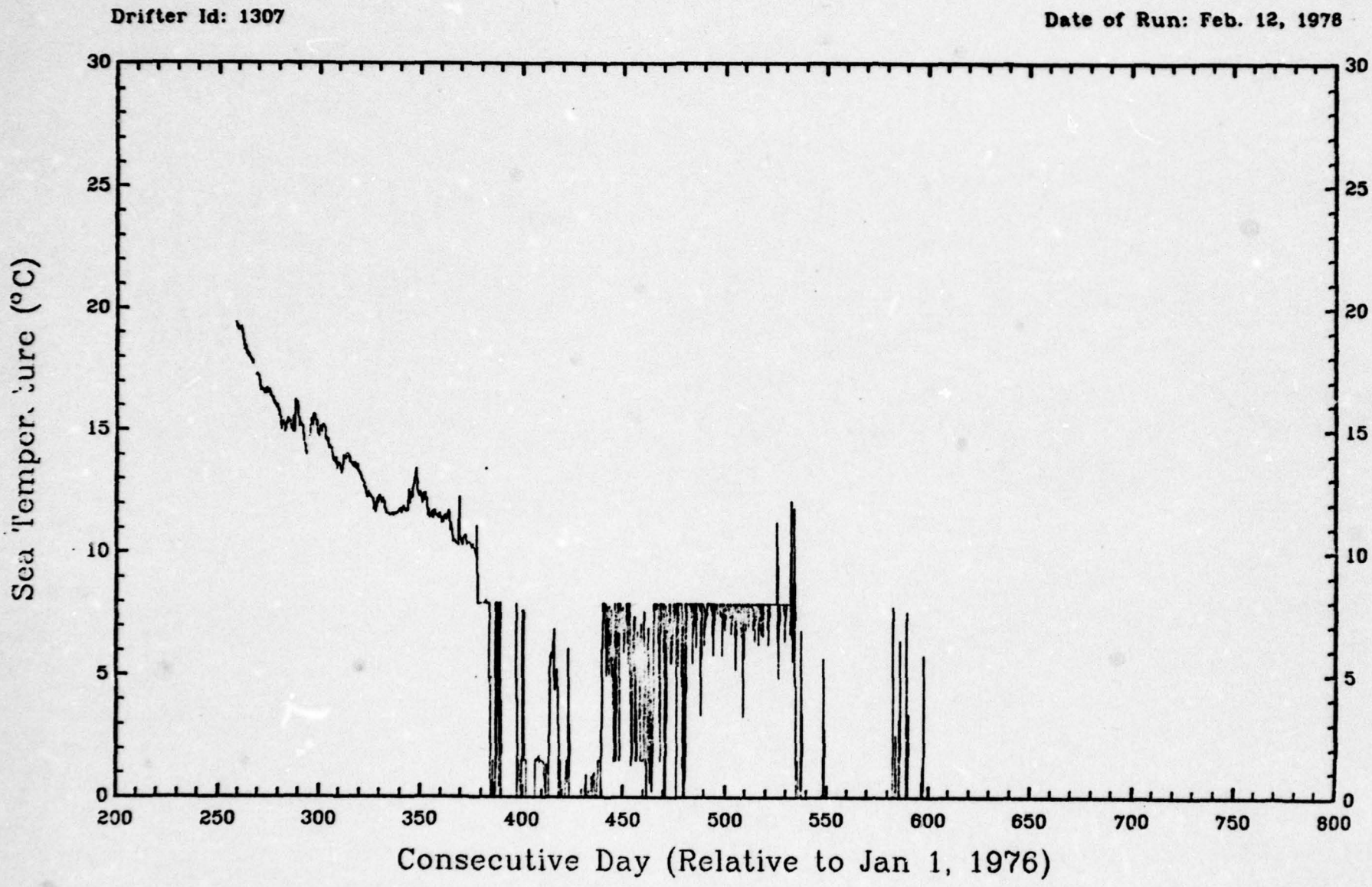


Drifter Trajectories
Velocity Checked Positions


Drifter Id: 1307
Date of Run: Feb. 6, 1978
Battery Volts (Volts)
12
10
8
6
4
2
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

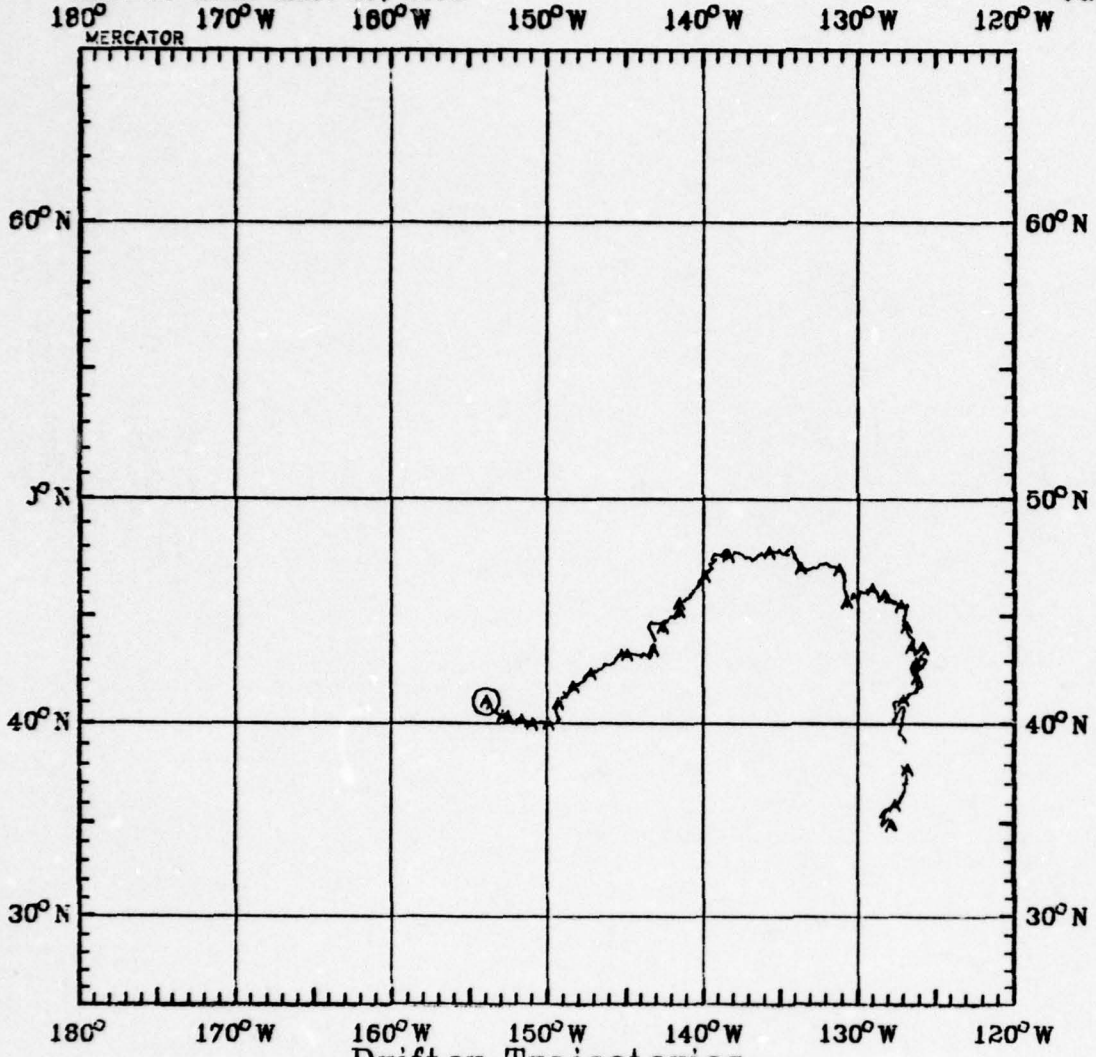

Drifter Id: 1307
Date of Run: Feb. 12, 1976
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1307
Date of Run: Feb. 12, 1978
Drogue, 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1307
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
30
25
20
15
10
5
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Date of Run: Mar. 17, 1978

Period Covered:
June 1, 1976 to Mar. 17, 1978



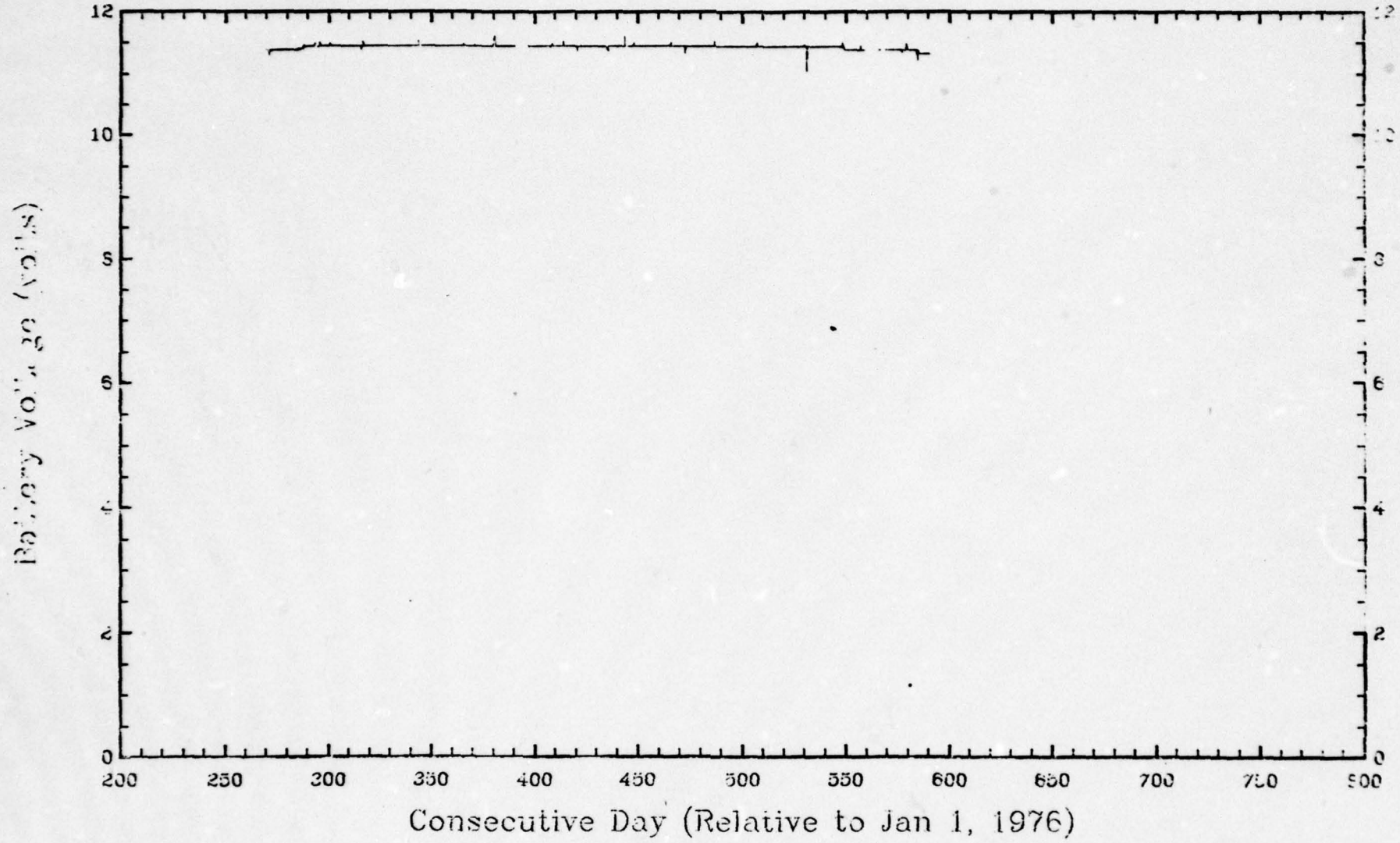
Symbol	Drifter Id
^	1331

Drifter Trajectories

Positions Computed by Interpolation

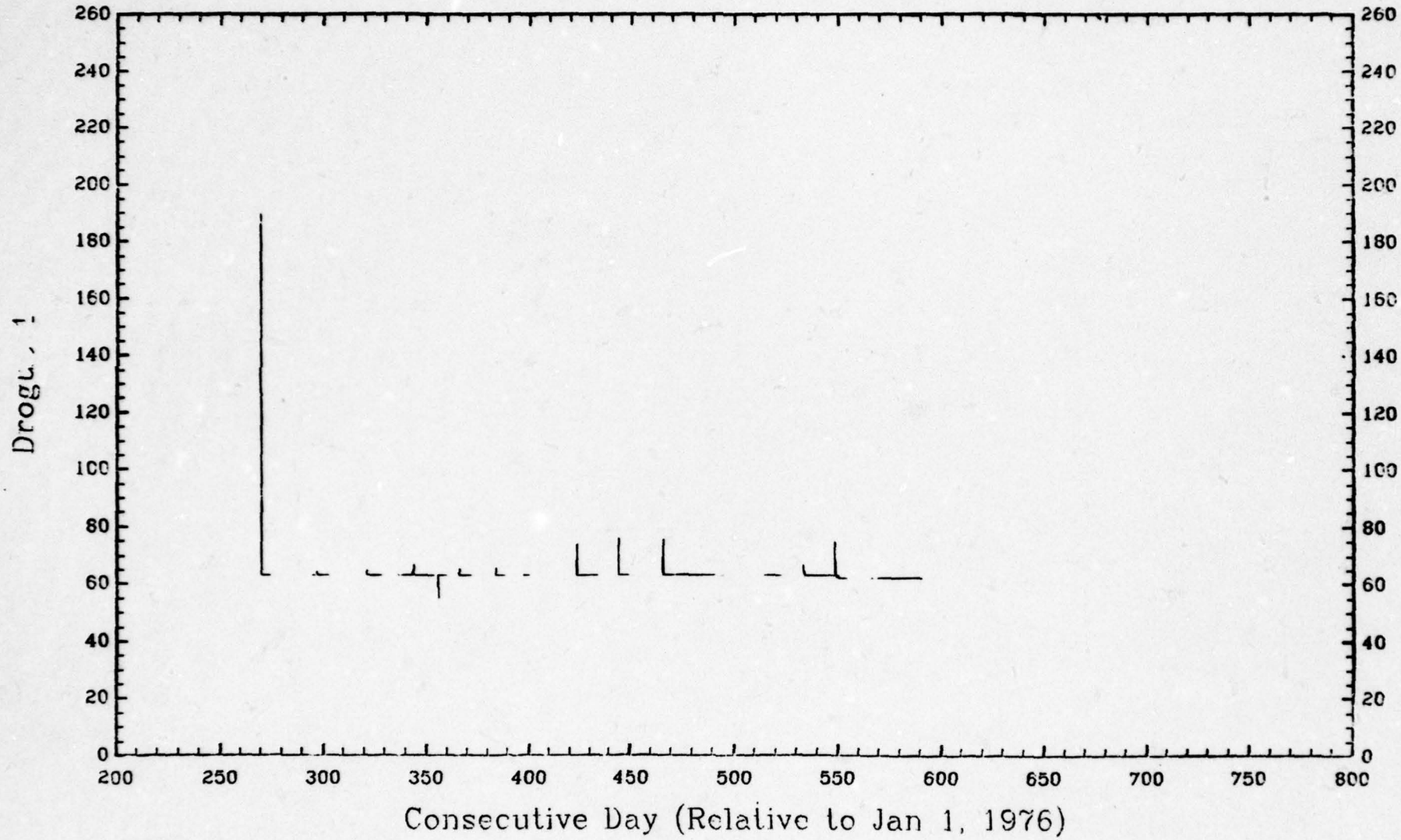
Drifter Id: 1331

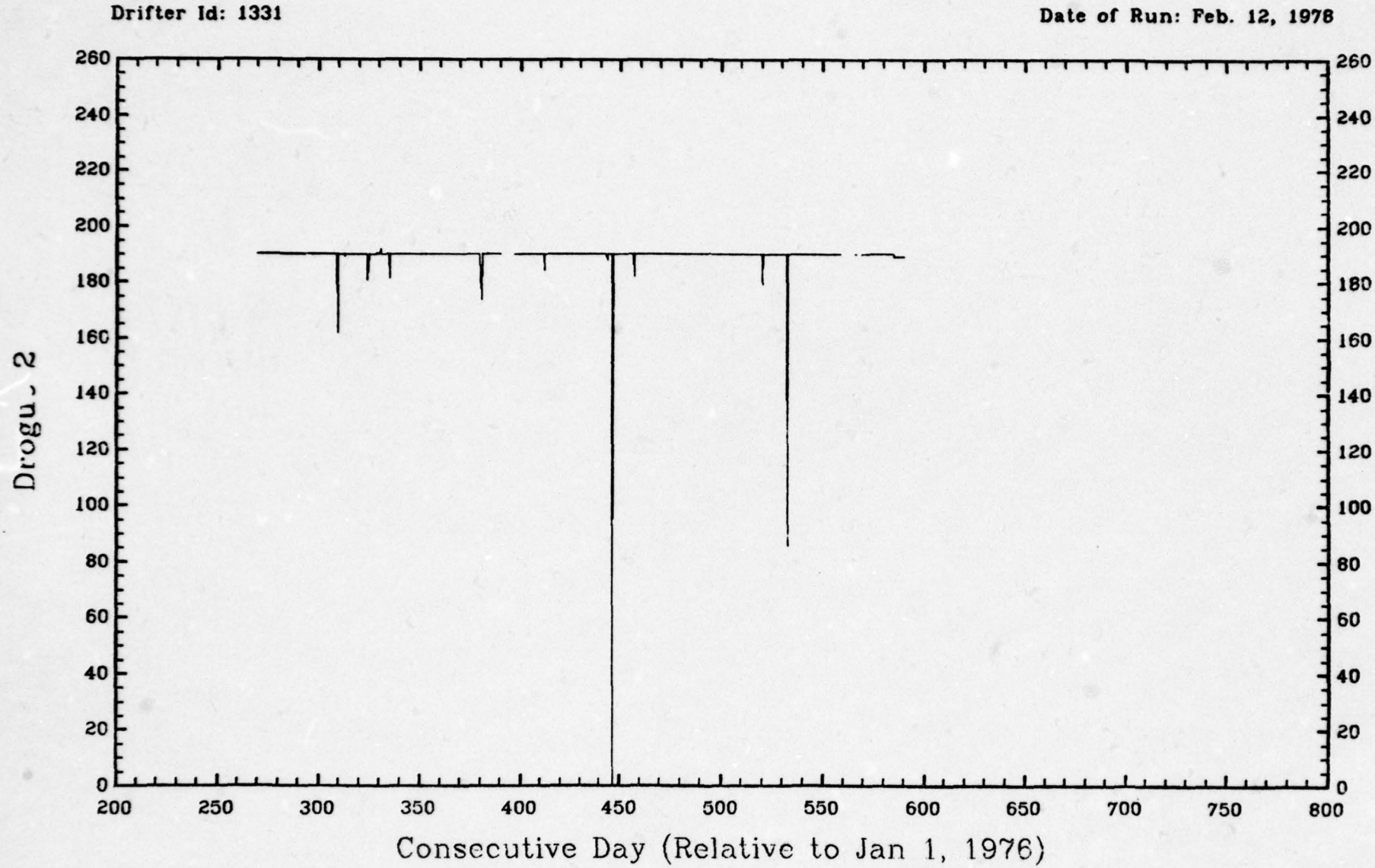
Date of Run: Feb. 6, 1978

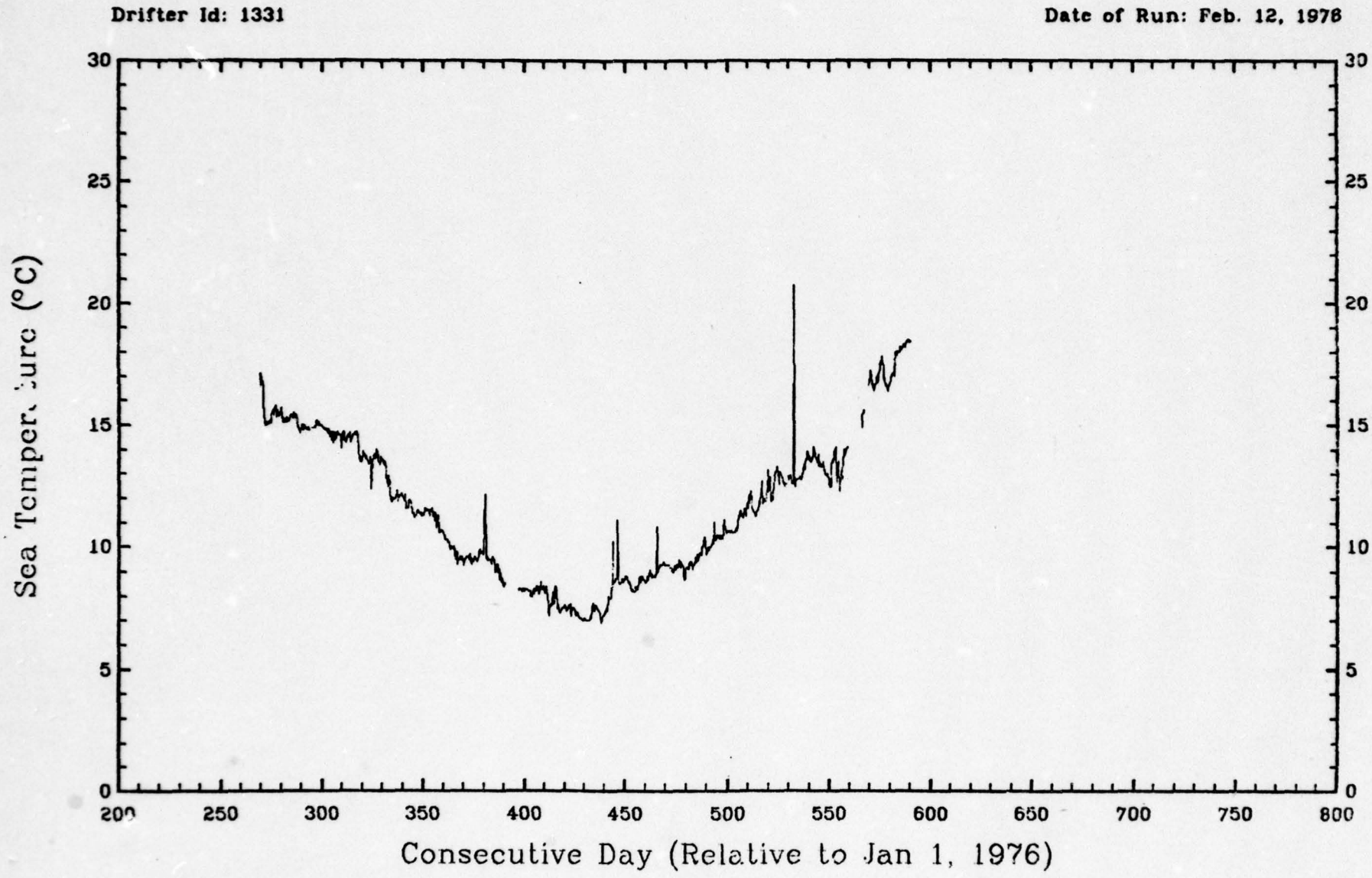


Drifter Id: 1331

Date of Run: Feb. 12, 1978

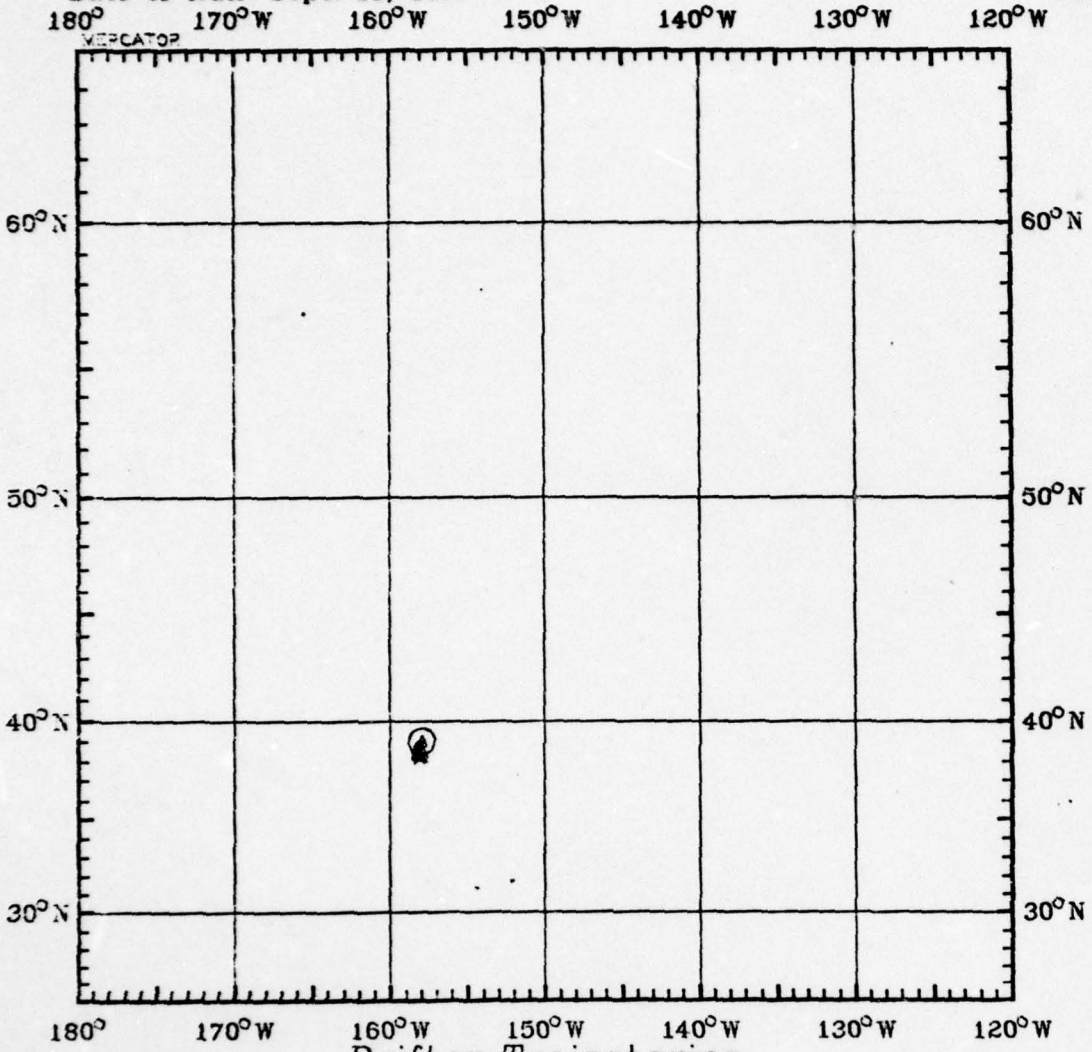



Drifter Id: 1331
Date of Run: Feb. 12, 1978
Drogue - 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1331
Date of Run: Feb. 12, 1976
Sea Temperature (°C)
30
25
20
15
10
5
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

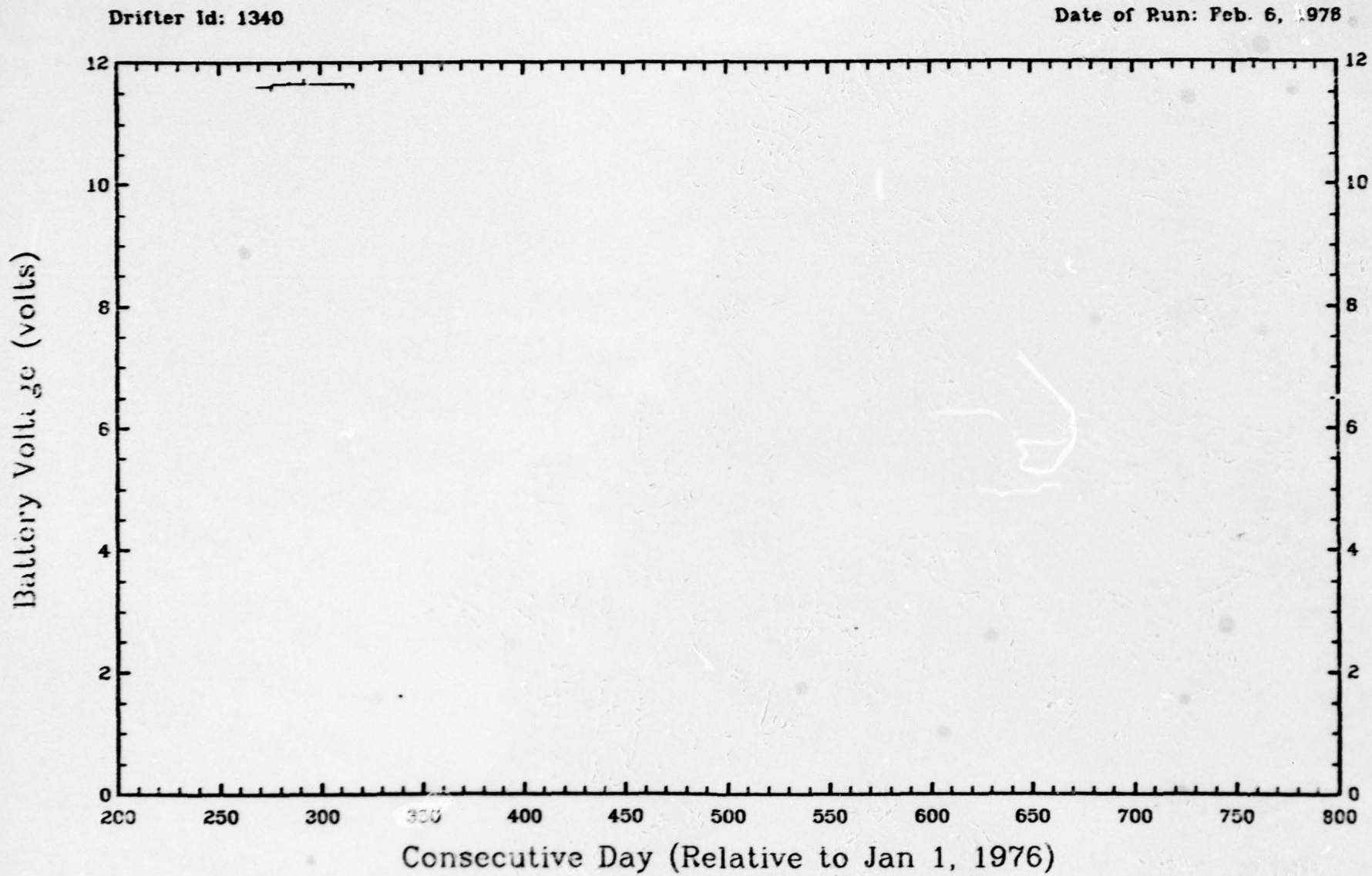
Date of Run: Sept. 15, 1977

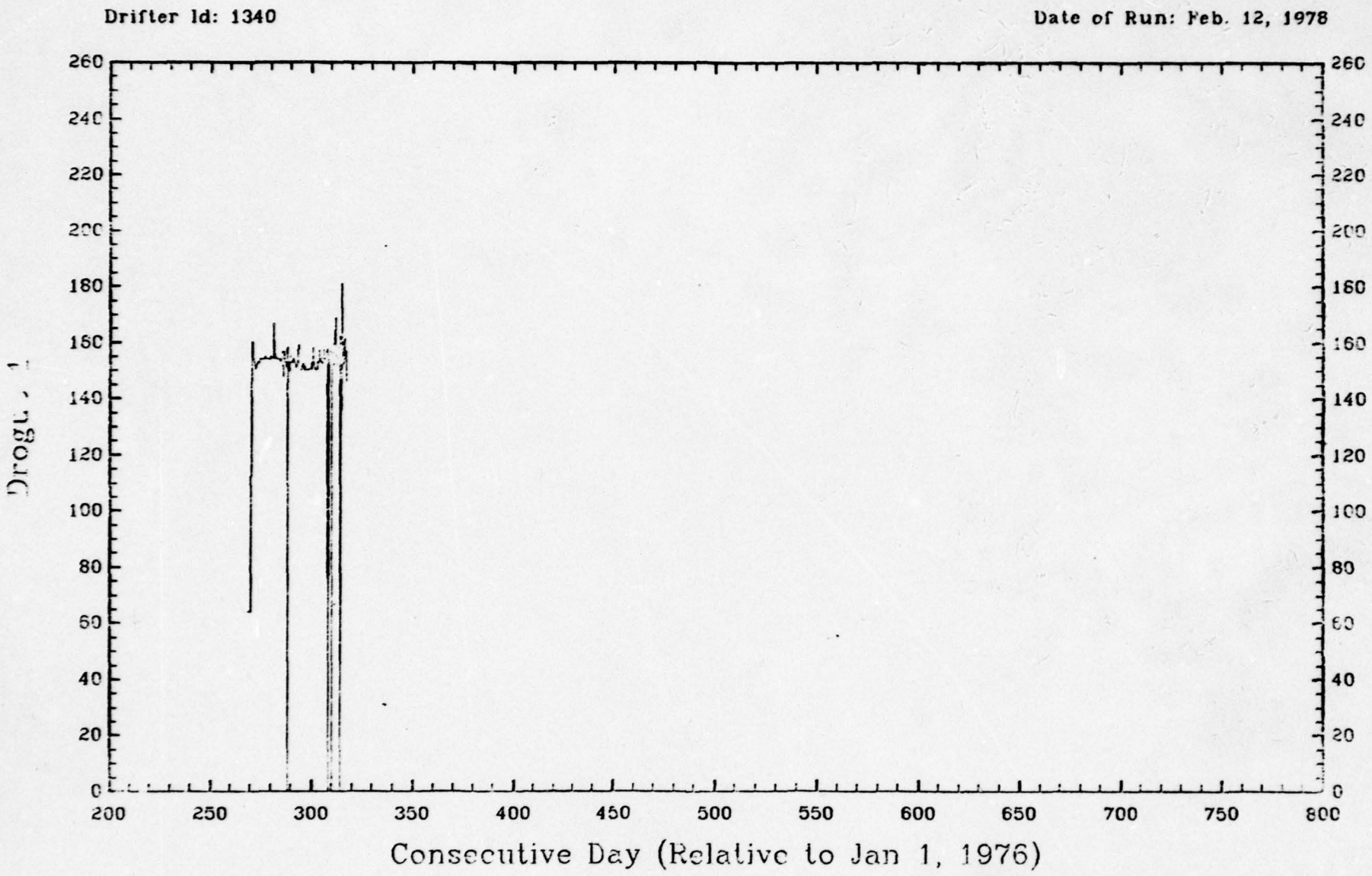
Period Covered:
June 1, 1976 to Sept. 15, 1977



Symbol	Drifter Id
^	1340

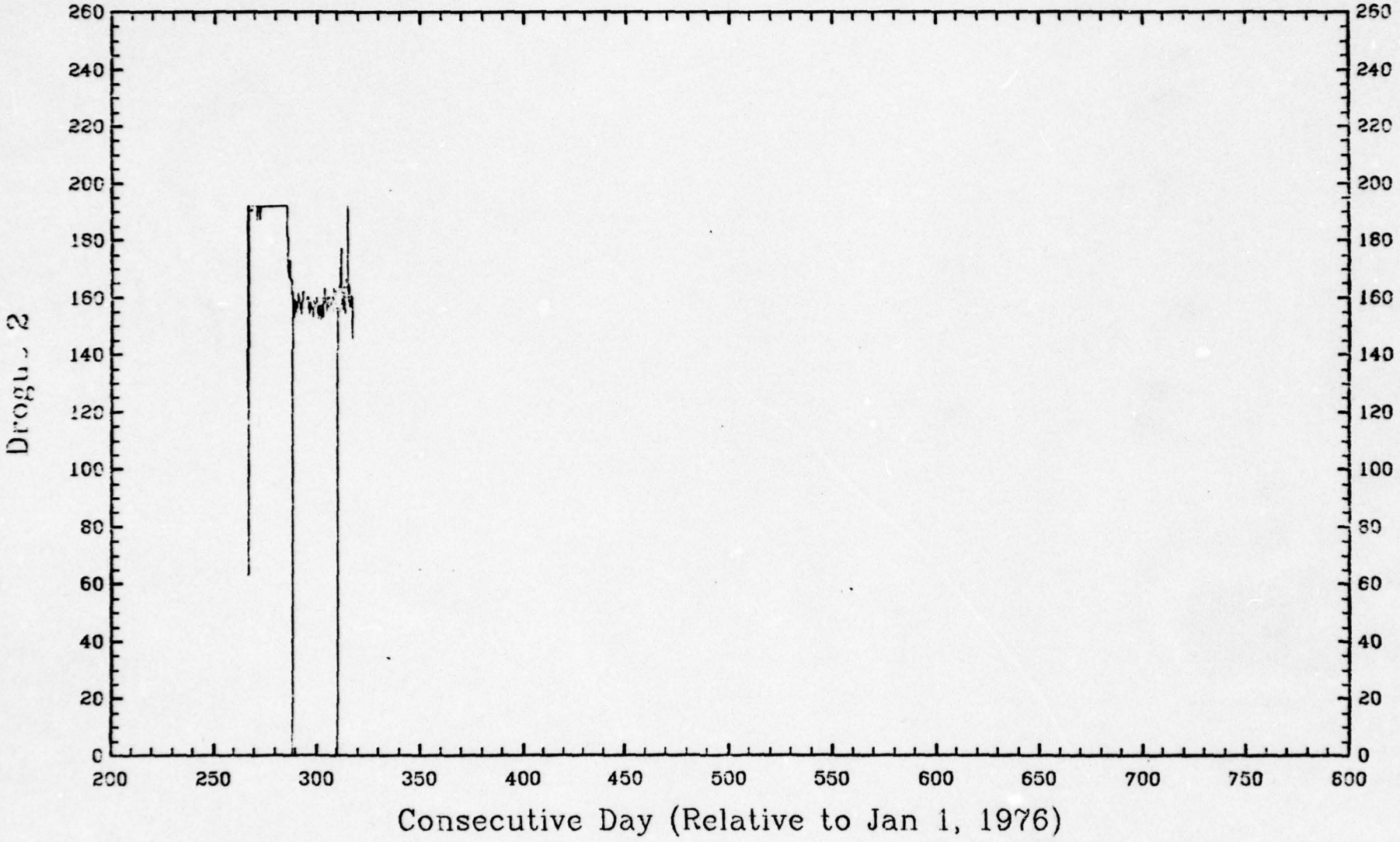
Drifter Trajectories
Velocity Checked Positions

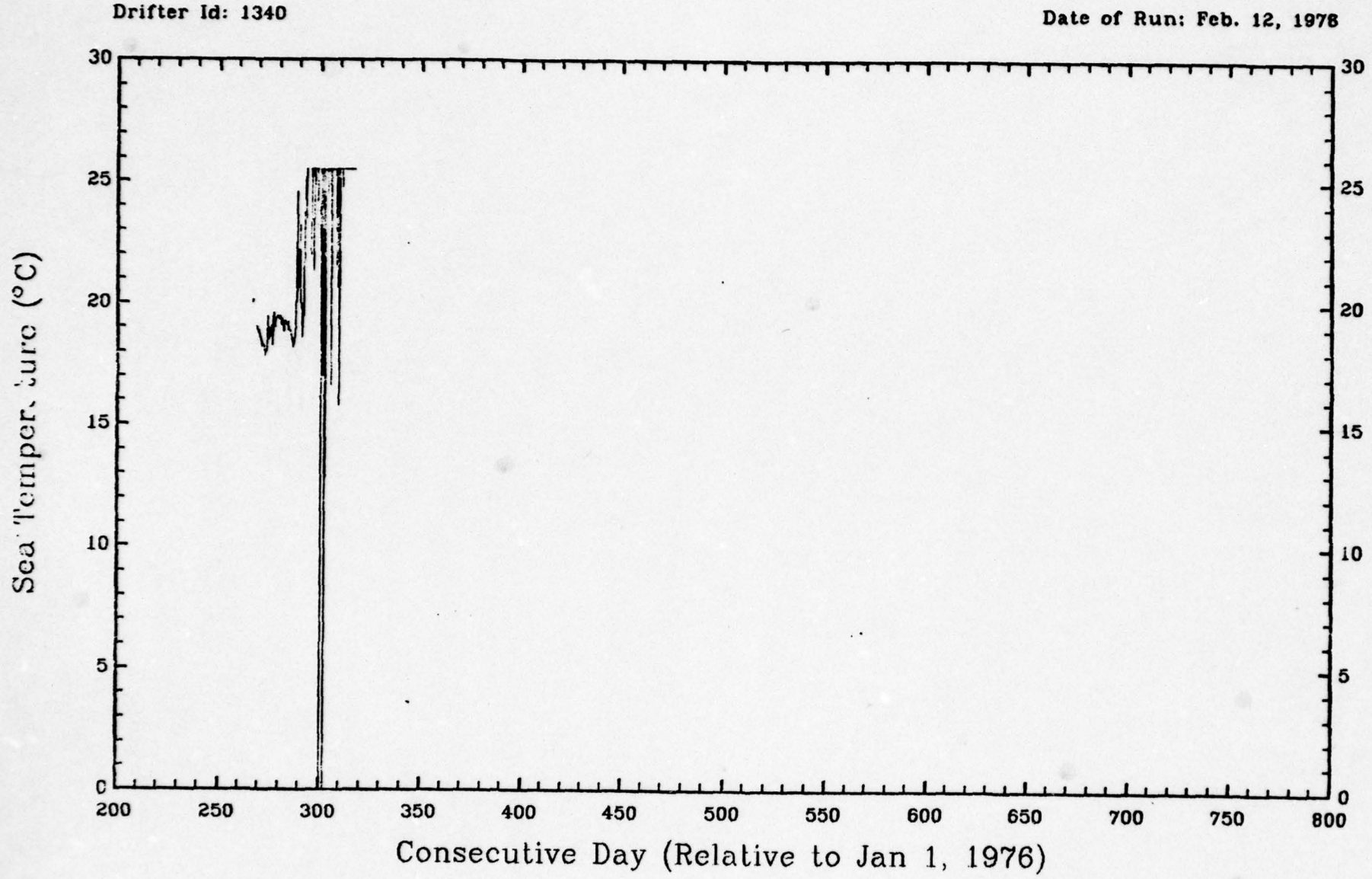

Drifter Id: 1340
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1340
Date of Run: Feb. 12, 1978
Drogue
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1340

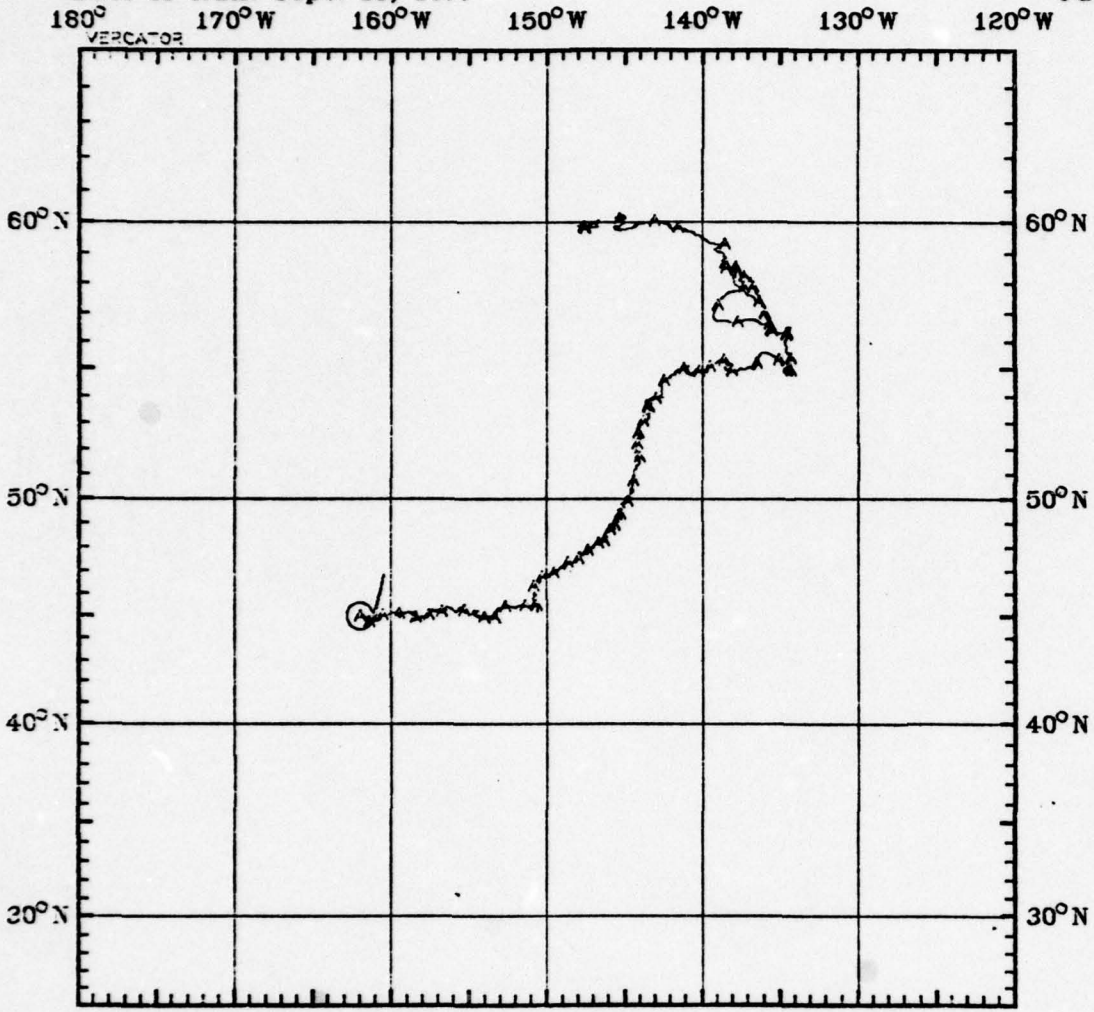
Date of Run: Feb. 12, 1978




Drifter Id: 1340
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
30
25
20
15
10
5
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

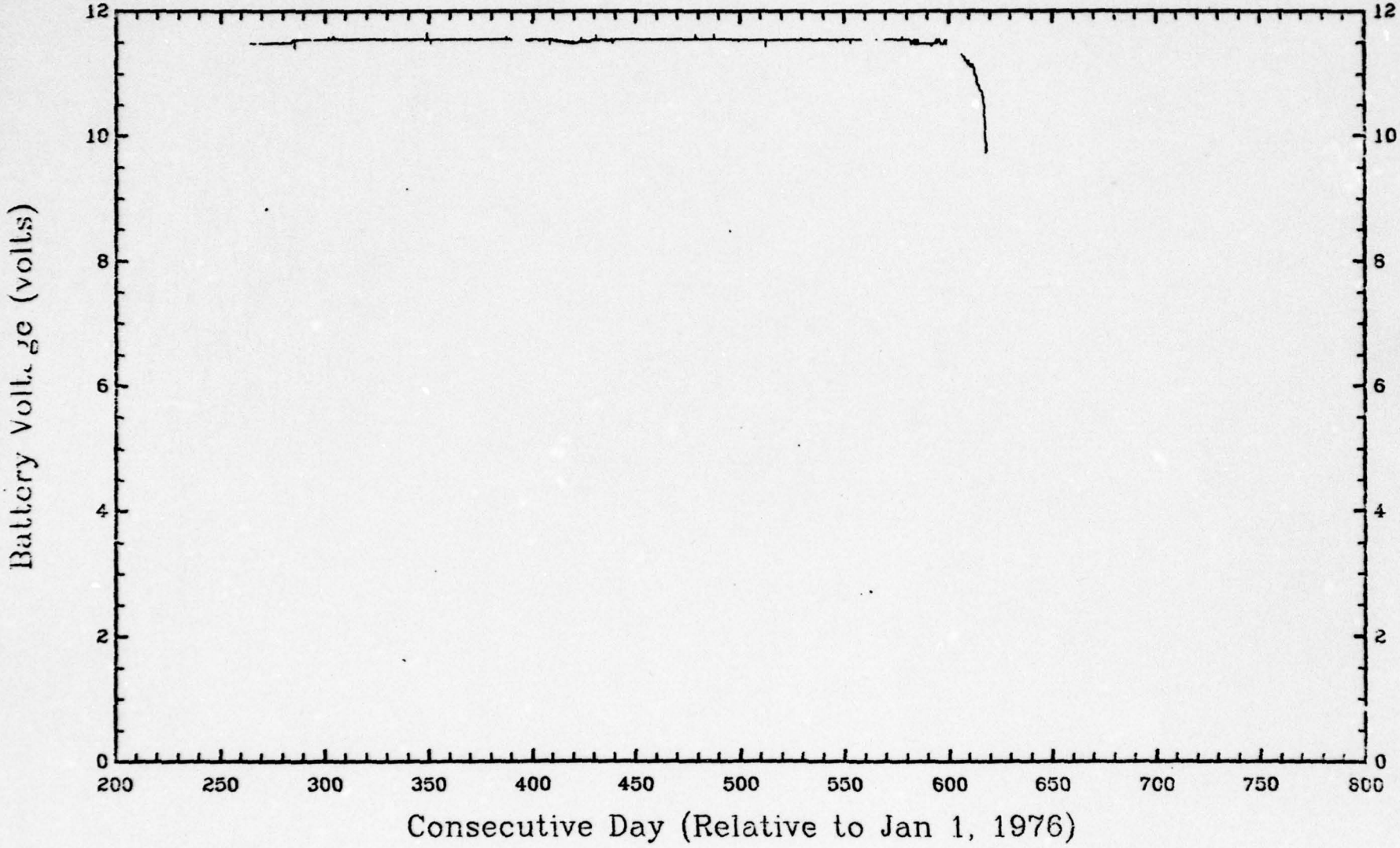


Symbol	Drifter Id
A	1376

Drifter Trajectories
Velocity Checked Positions

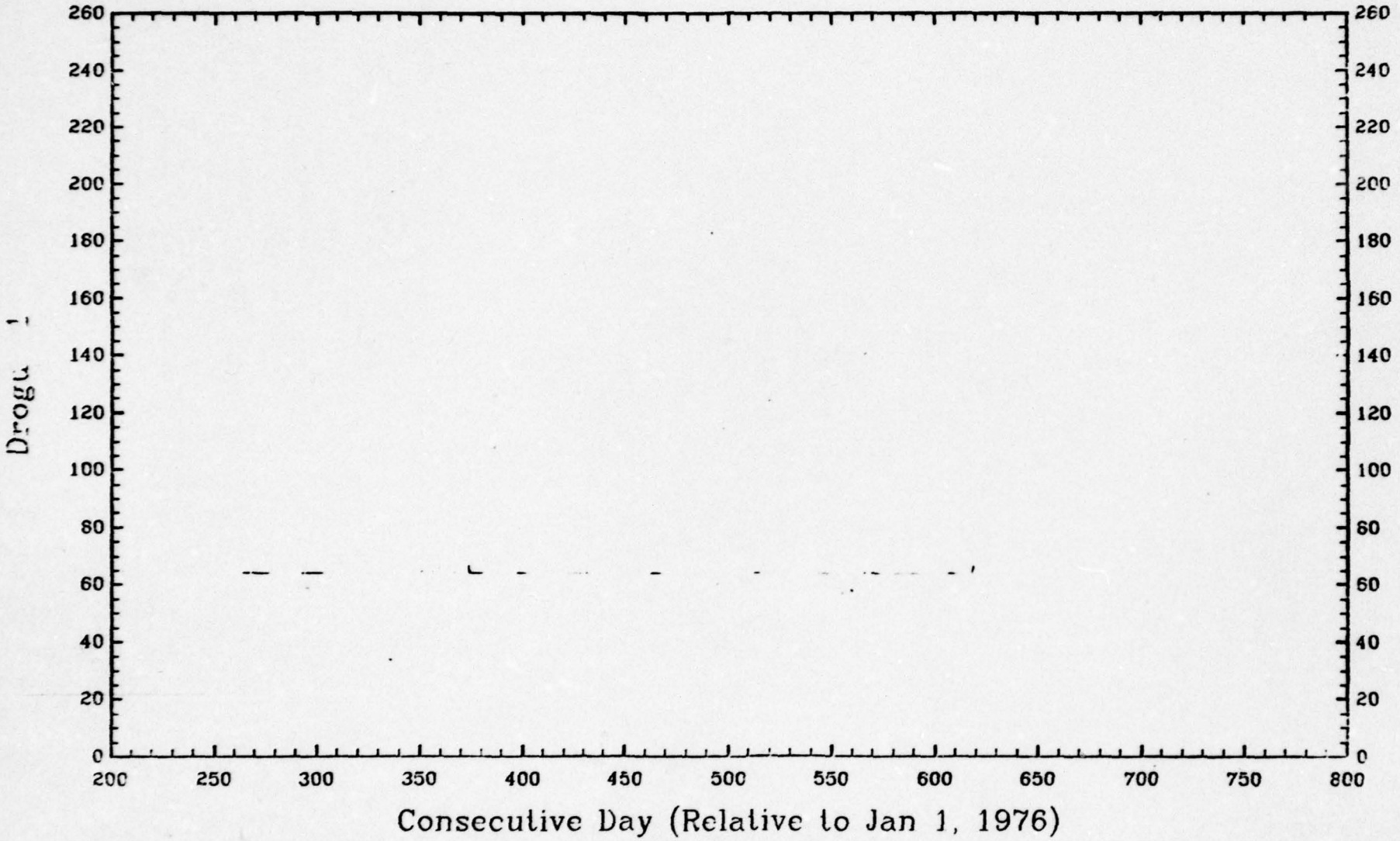
Drifter Id: 1376

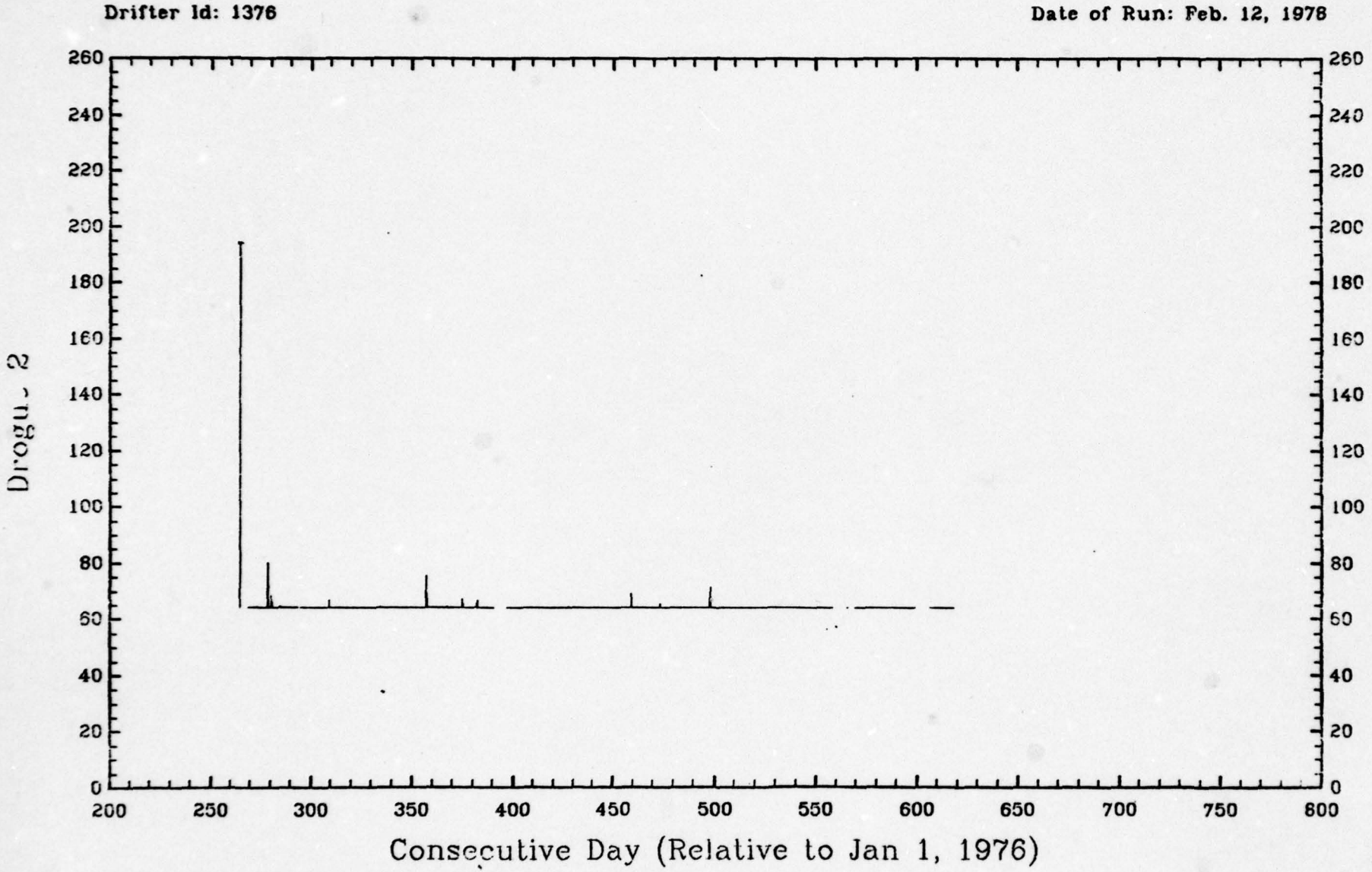
Date of Run: Feb. 6, 1978



Drifter Id: 1376

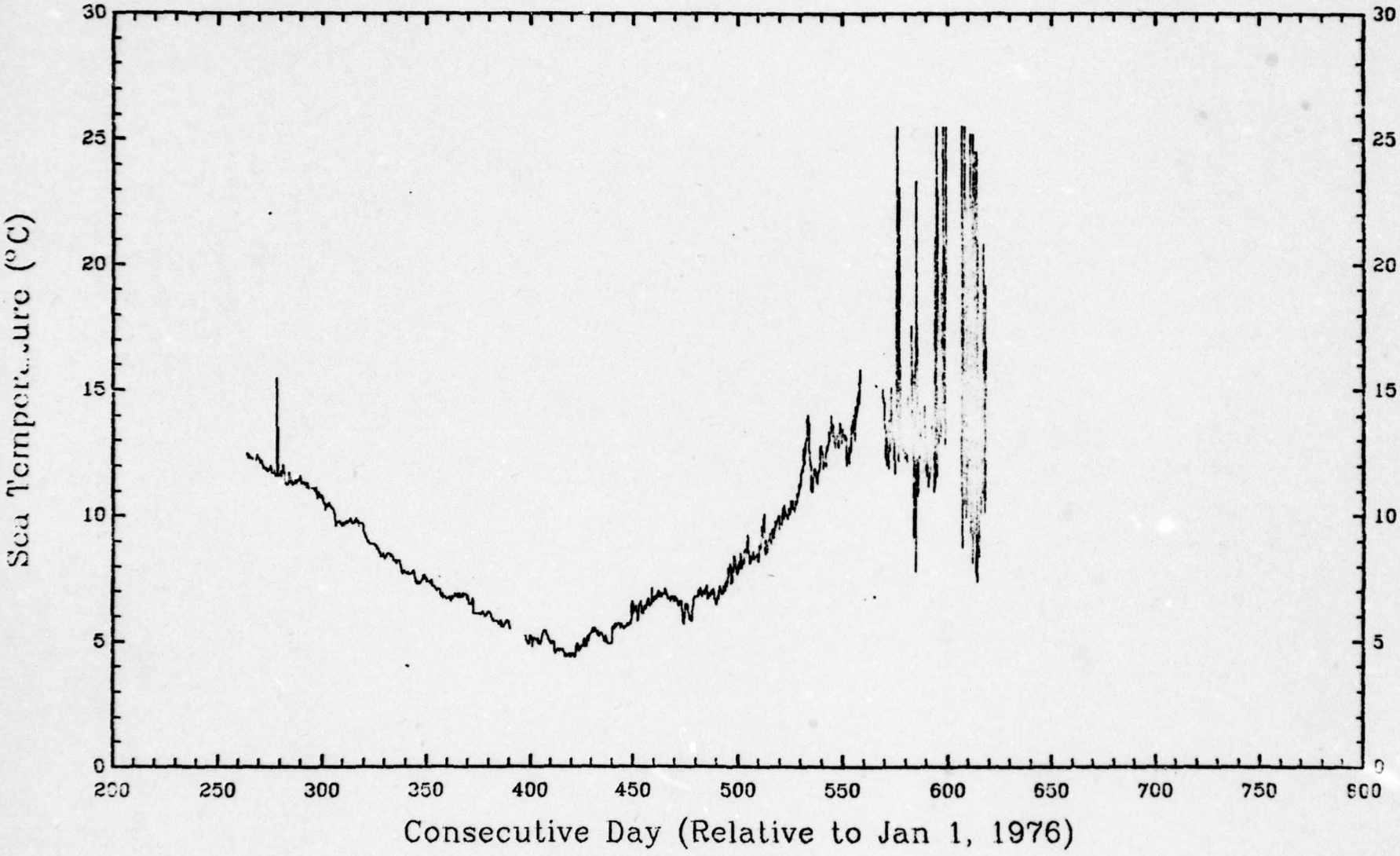
Date of Run: Feb. 12, 1978




Drifter Id: 1376
Date of Run: Feb. 12, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1376

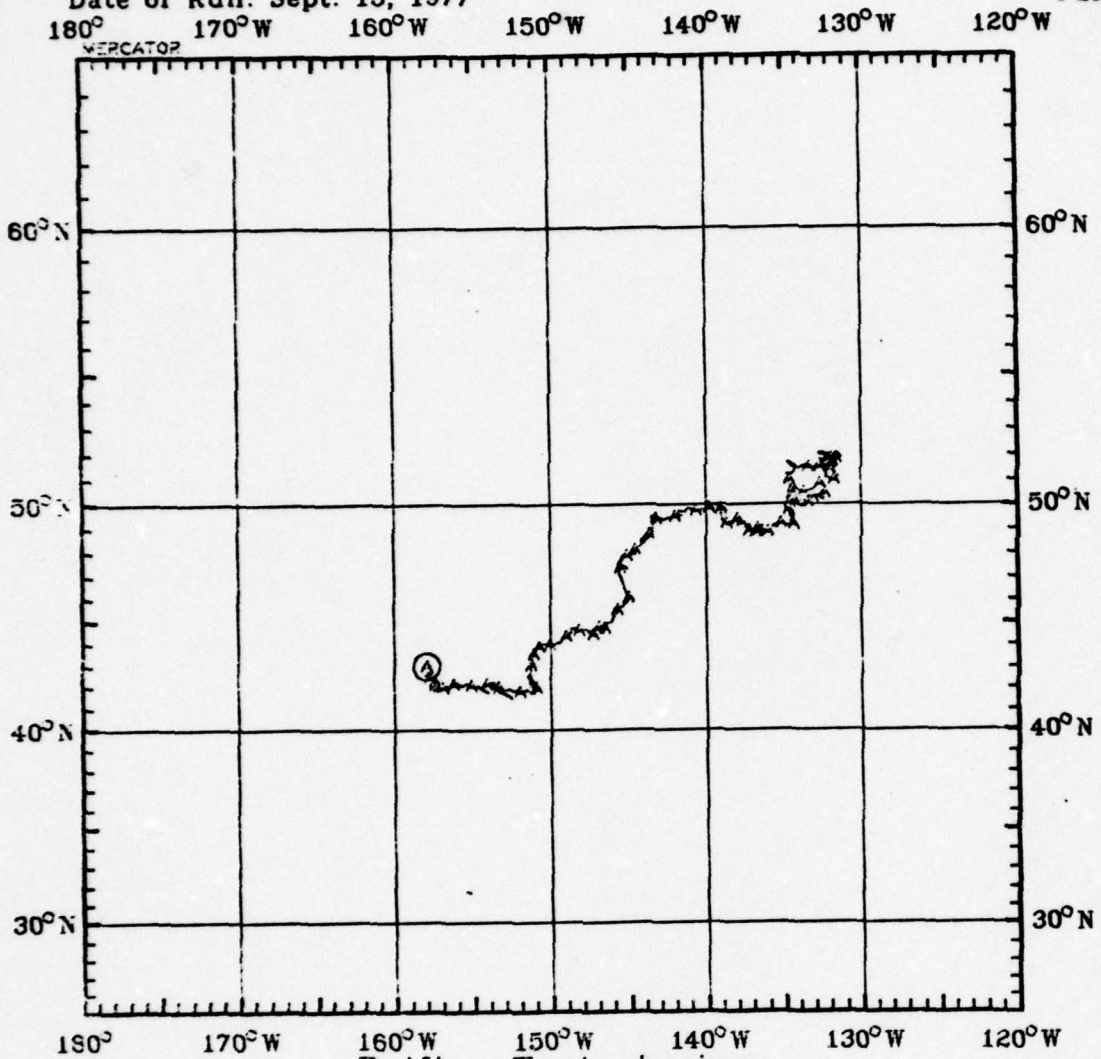
Date of Run: Feb. 12, 1978



Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

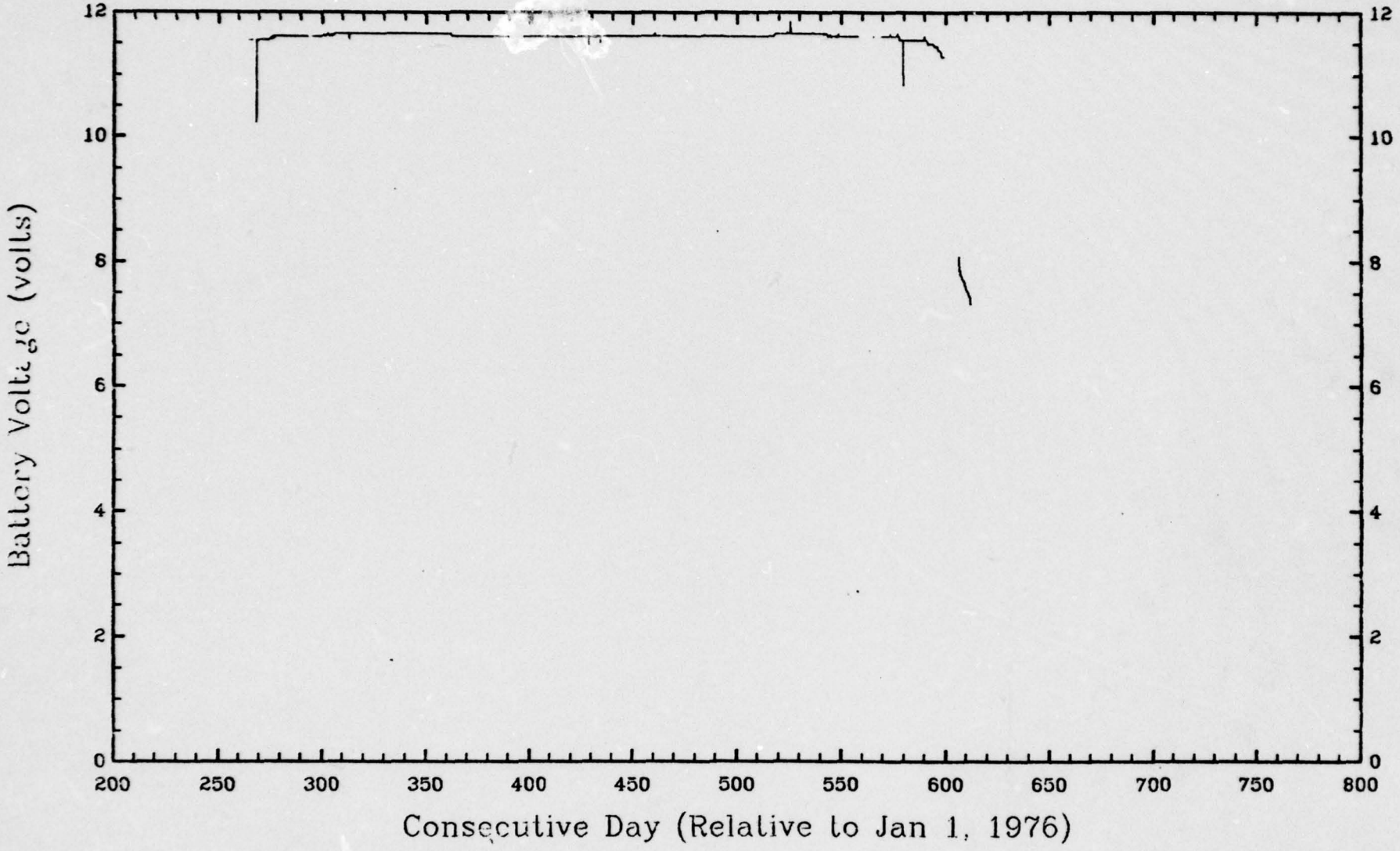
Symbol	Drifter Id
A	1513



Drifter Trajectories
Velocity Checked Positions

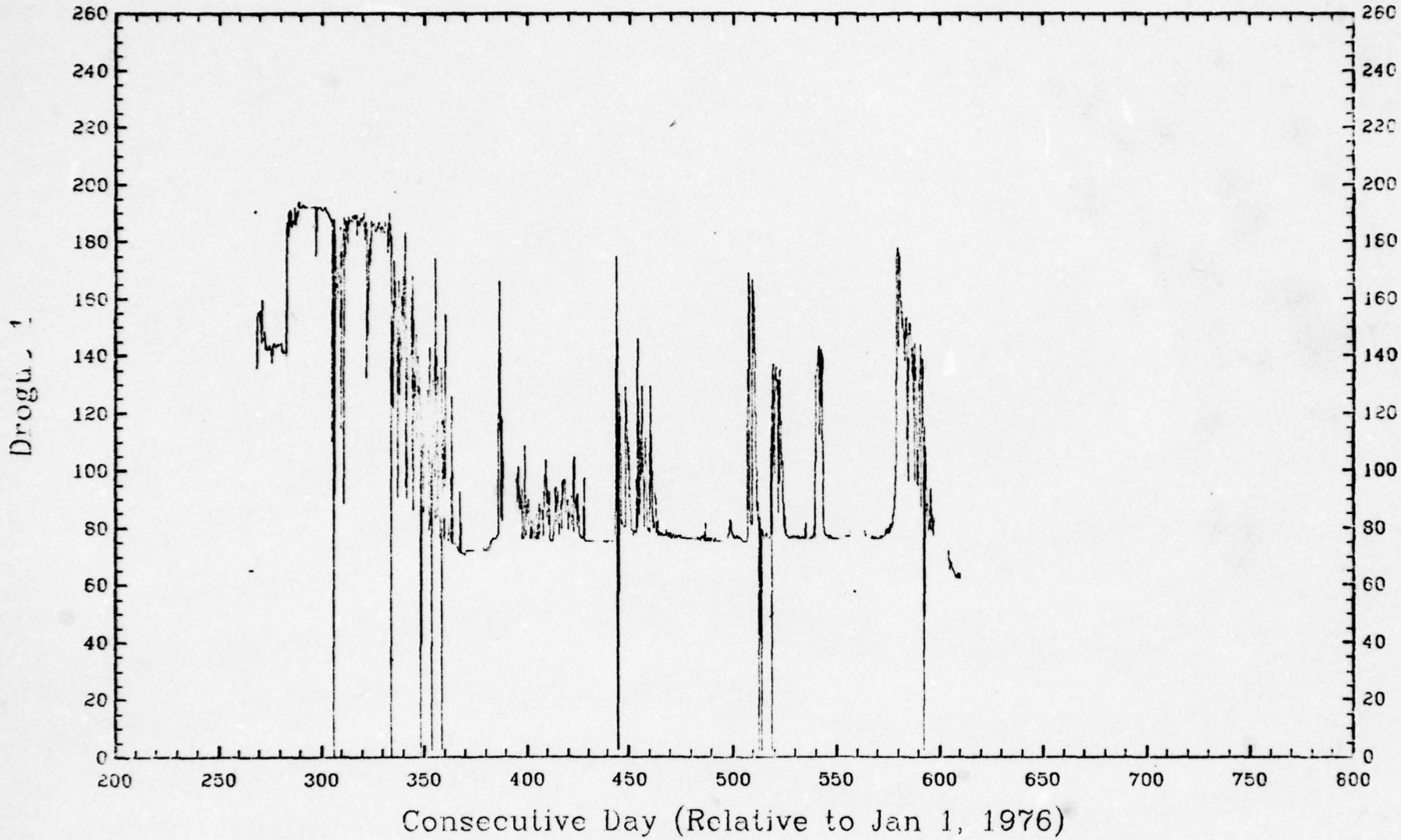
Drifter Id: 1513

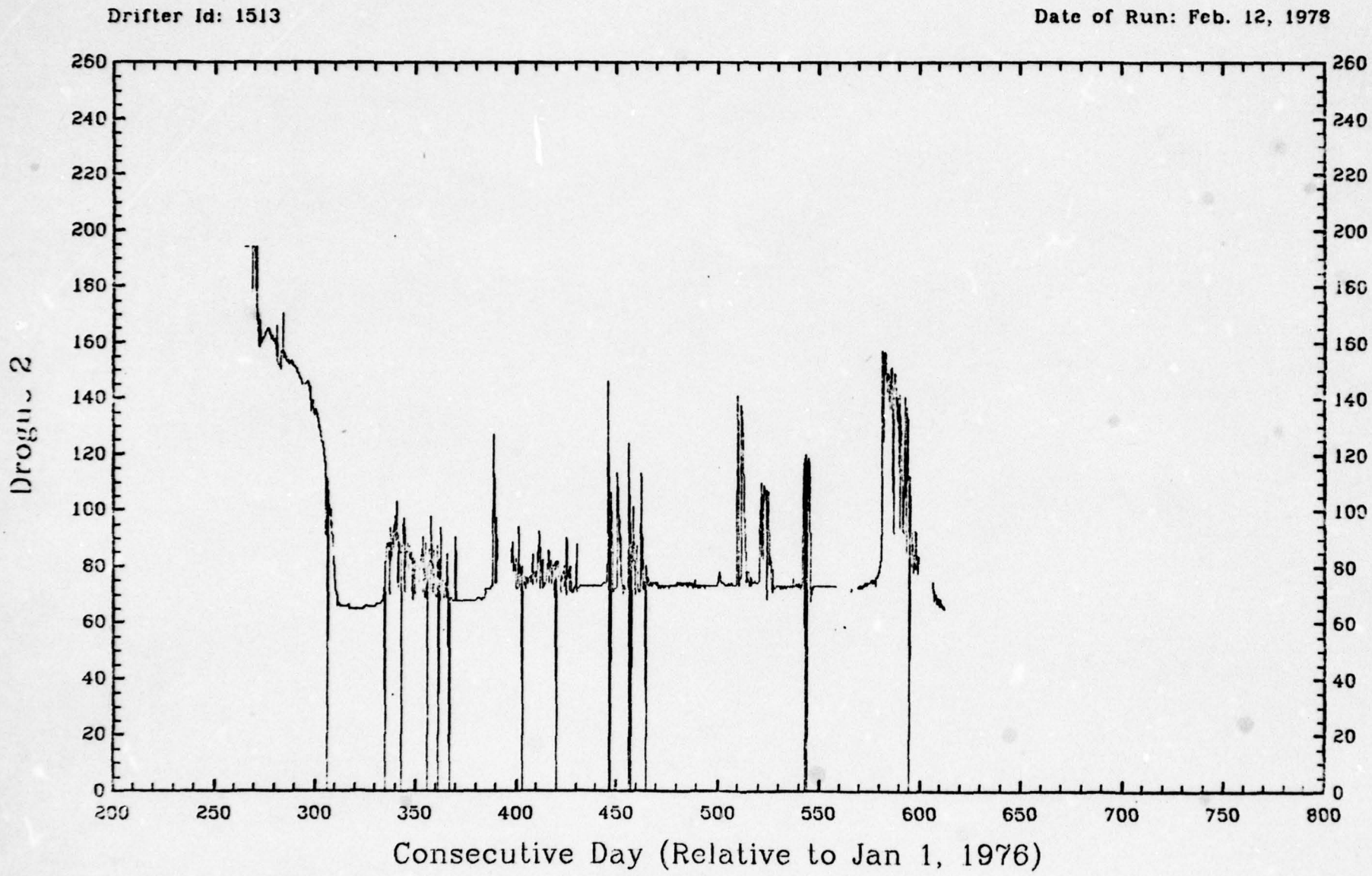
Date of Run: Feb. 6, 1978



Drifter Id: 1513

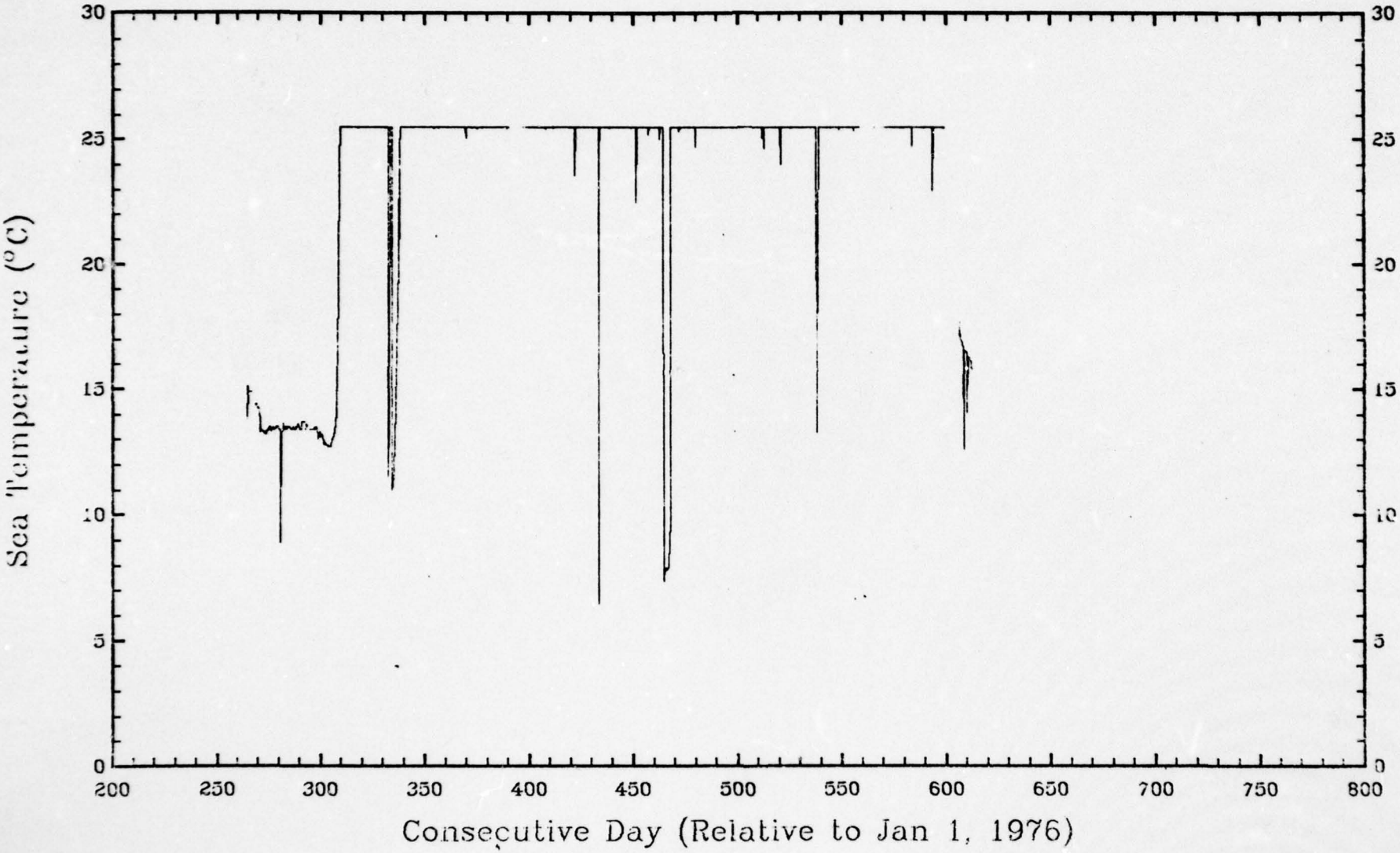
Date of Run: Feb. 12, 1978




Drifter Id: 1513
Date of Run: Feb. 12, 1978
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

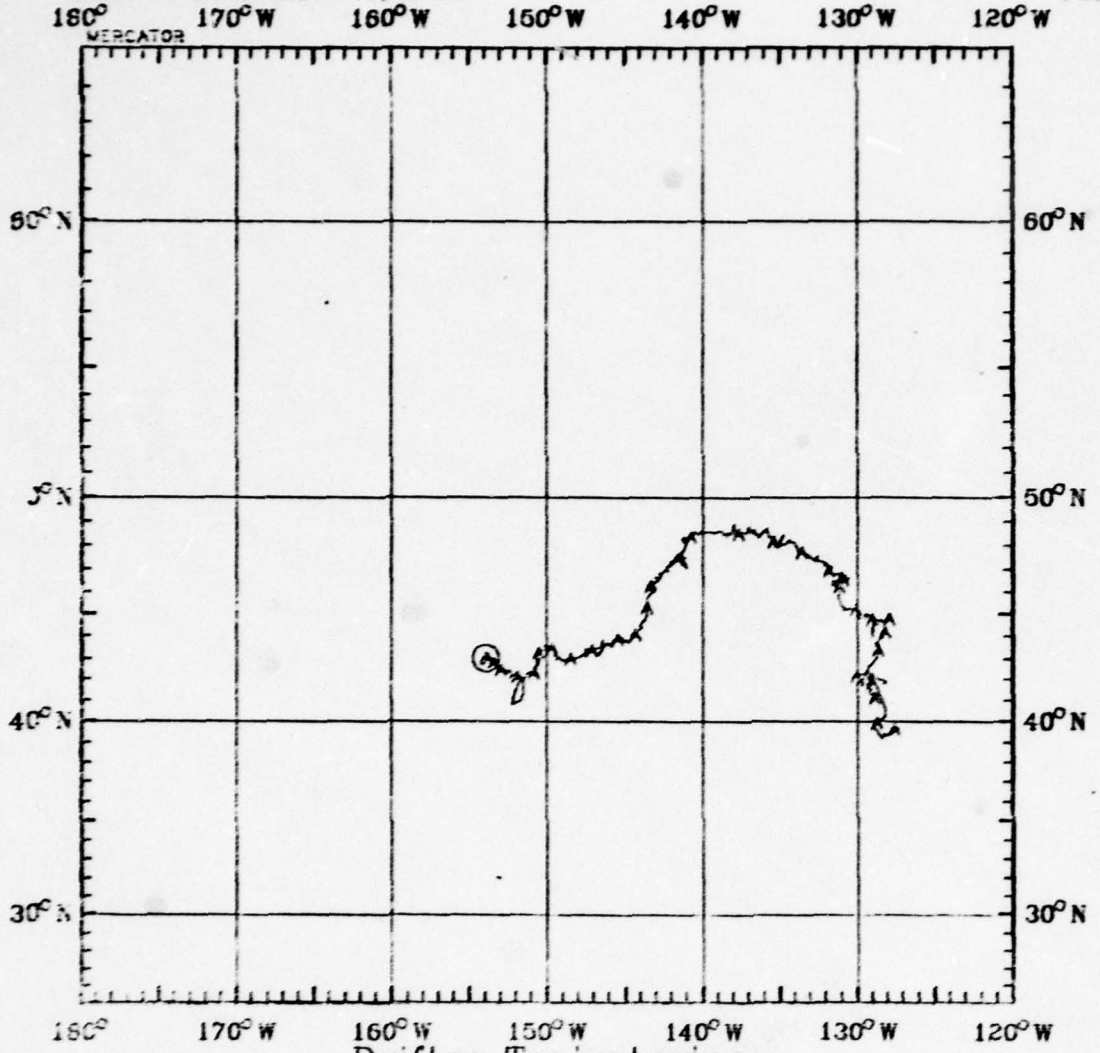
Drifter Id: 1513

Date of Run: Feb. 12, 1978



Date of Run: Mar. 17, 1978

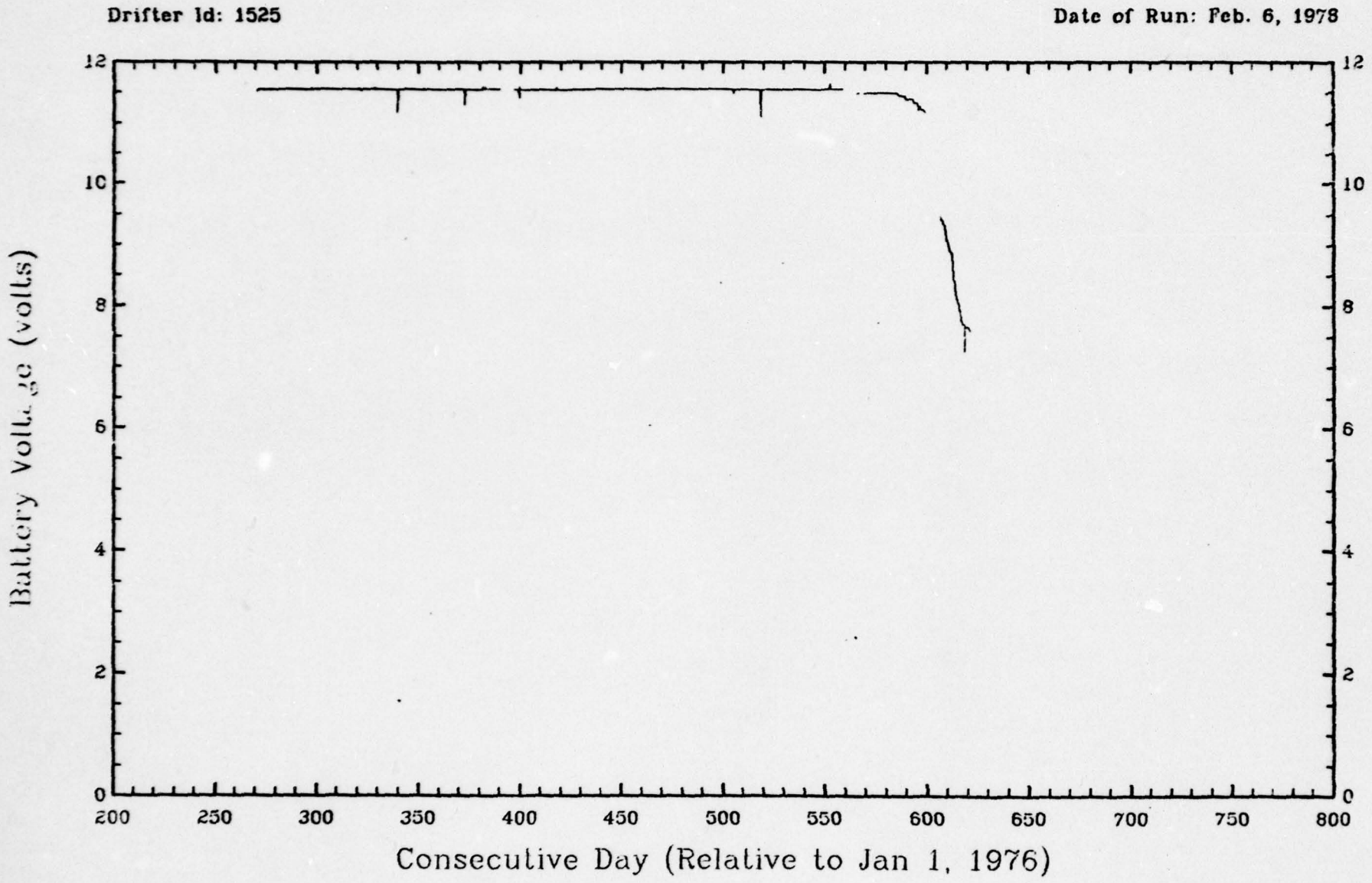
Period Covered:
June 1, 1976 to Mar. 17, 1978

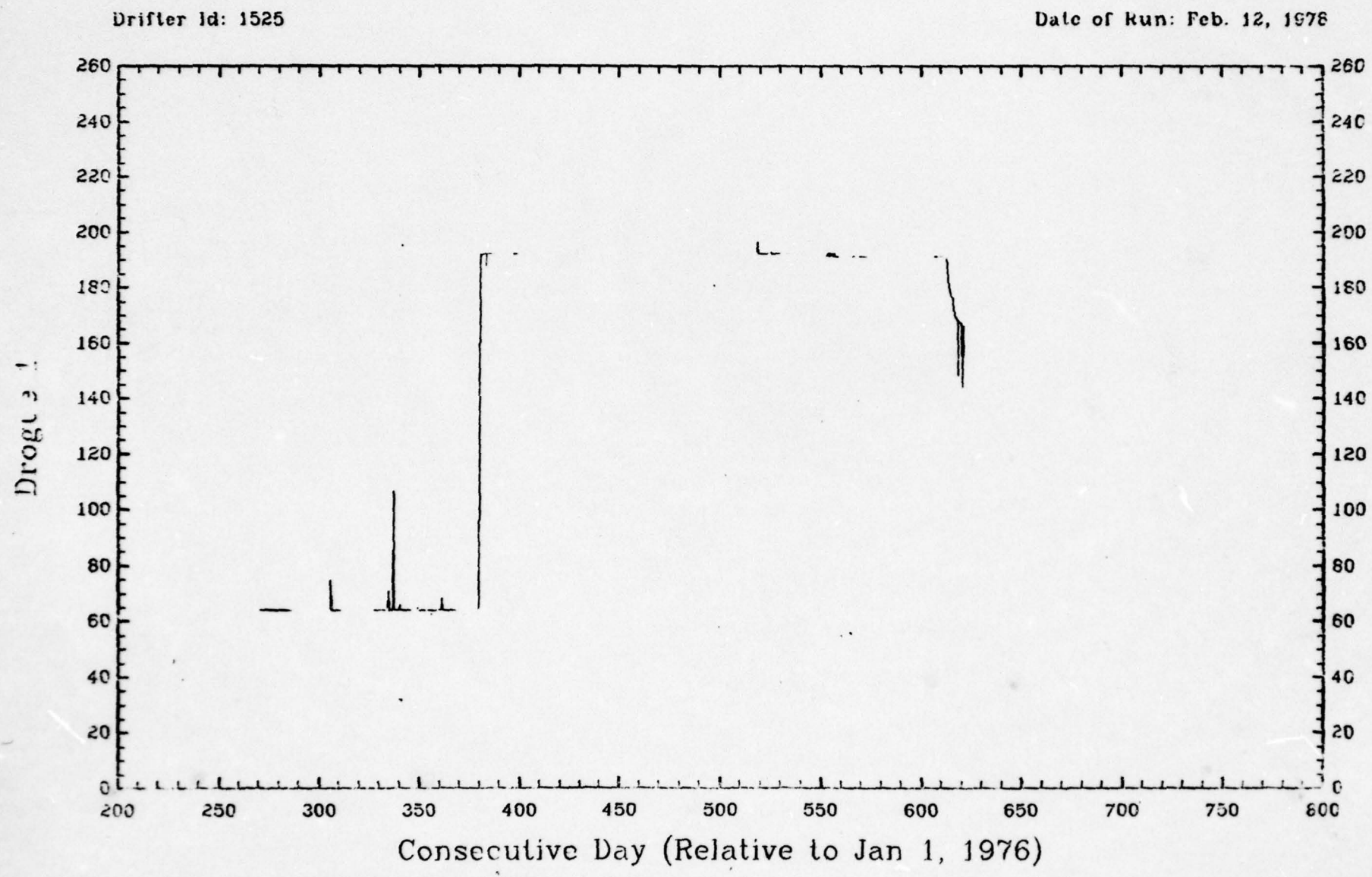


Symbol	Drifter Id
A	1525

Drifter Trajectories

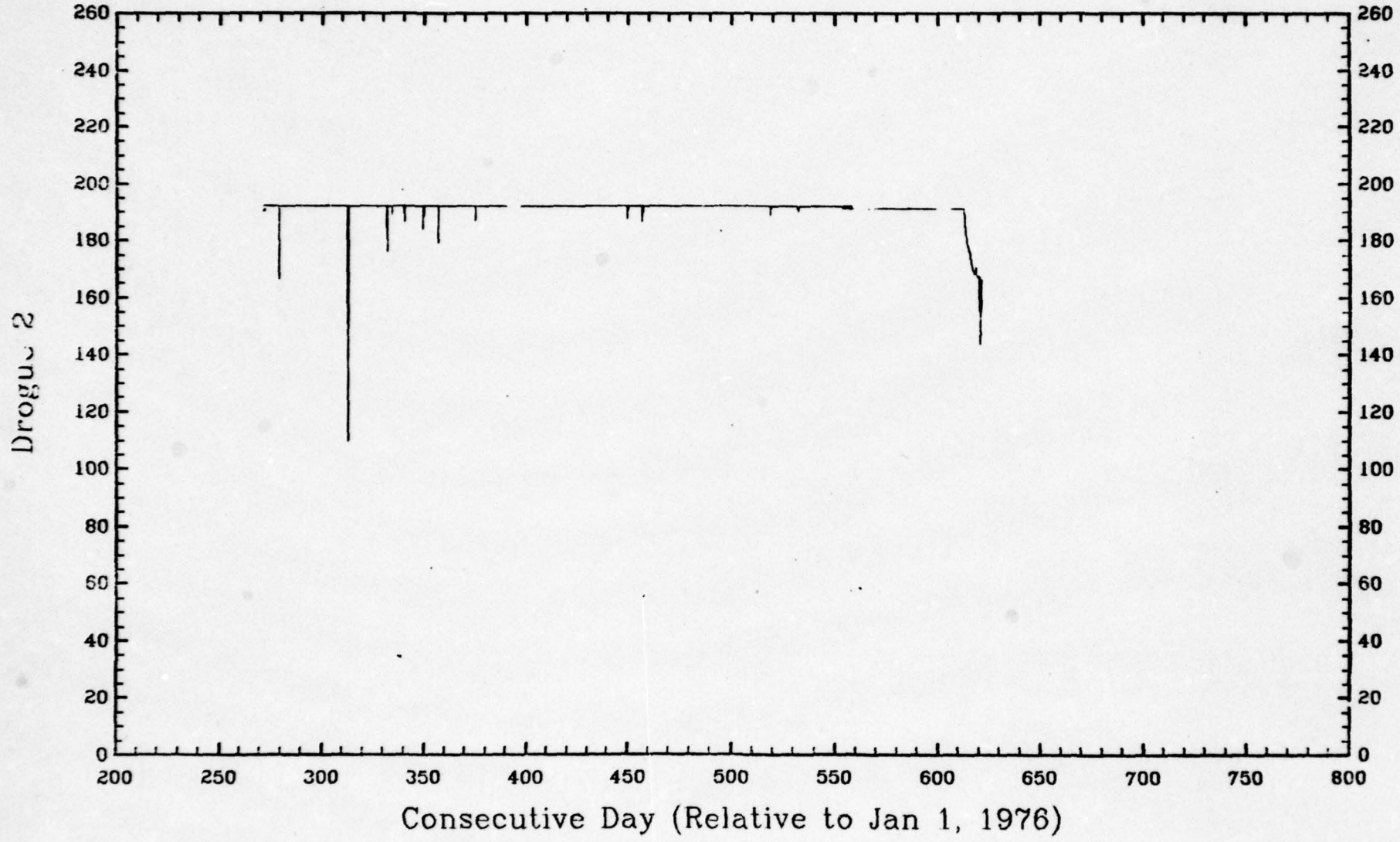
Positions Computed by Interpolation


Drifter Id: 1525
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1525
Date of Run: Feb. 12, 1976
Drogue at
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

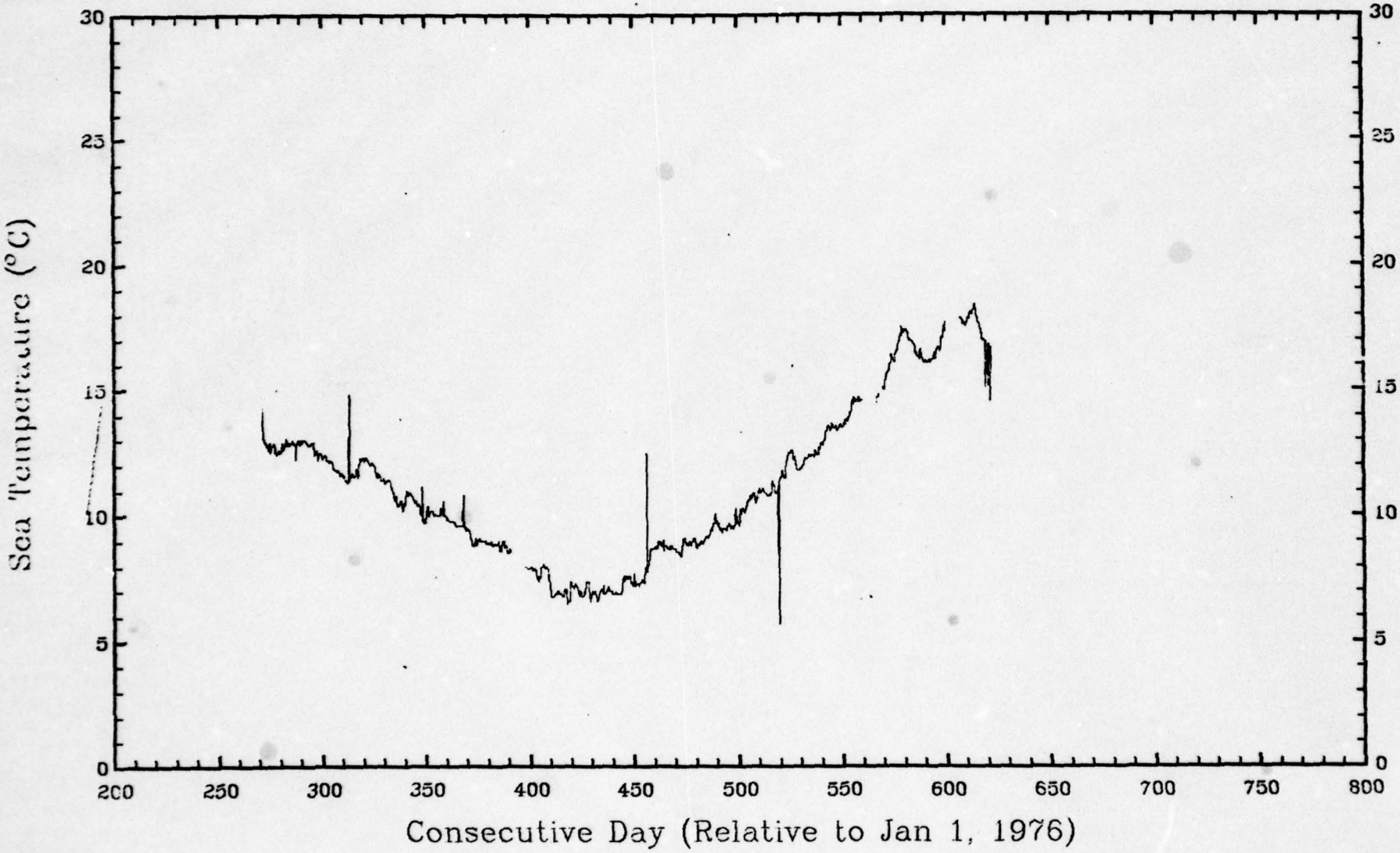
Drifter Id: 1525

Date of Run: Feb. 12, 1978



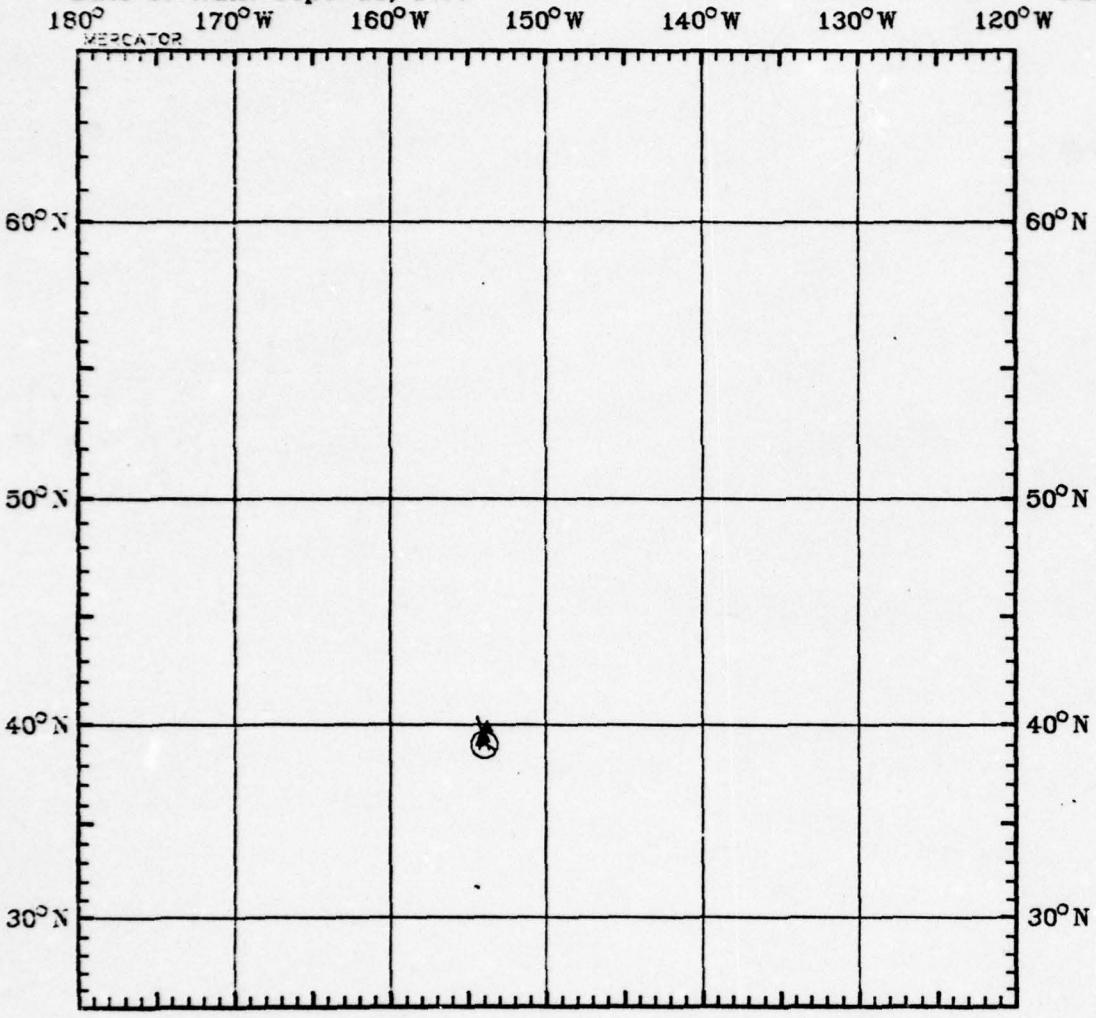
Drifter Id: 1525

Date of Run: Feb. 12, 1978



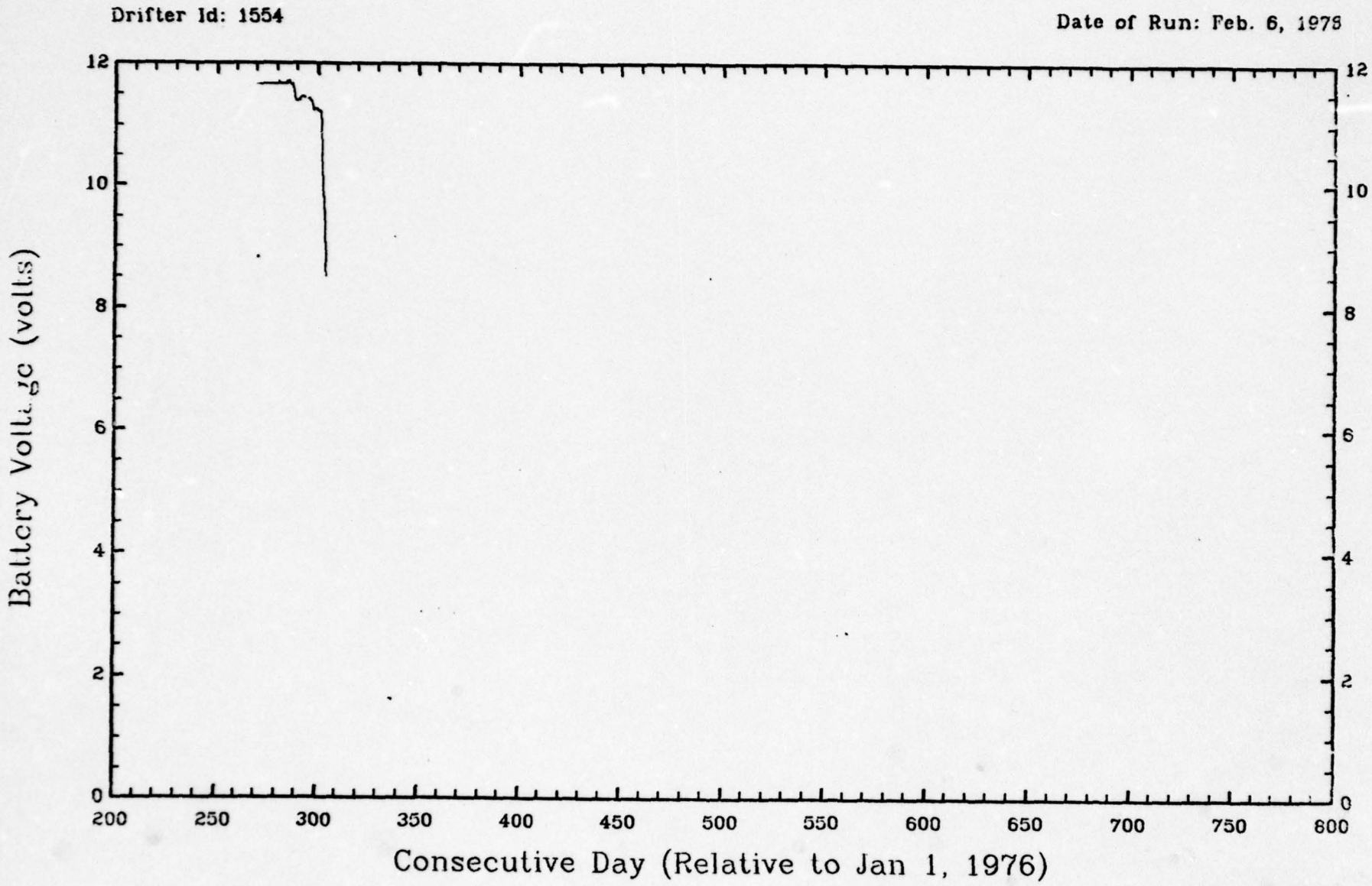
Date of Run: Sept. 15, 1977

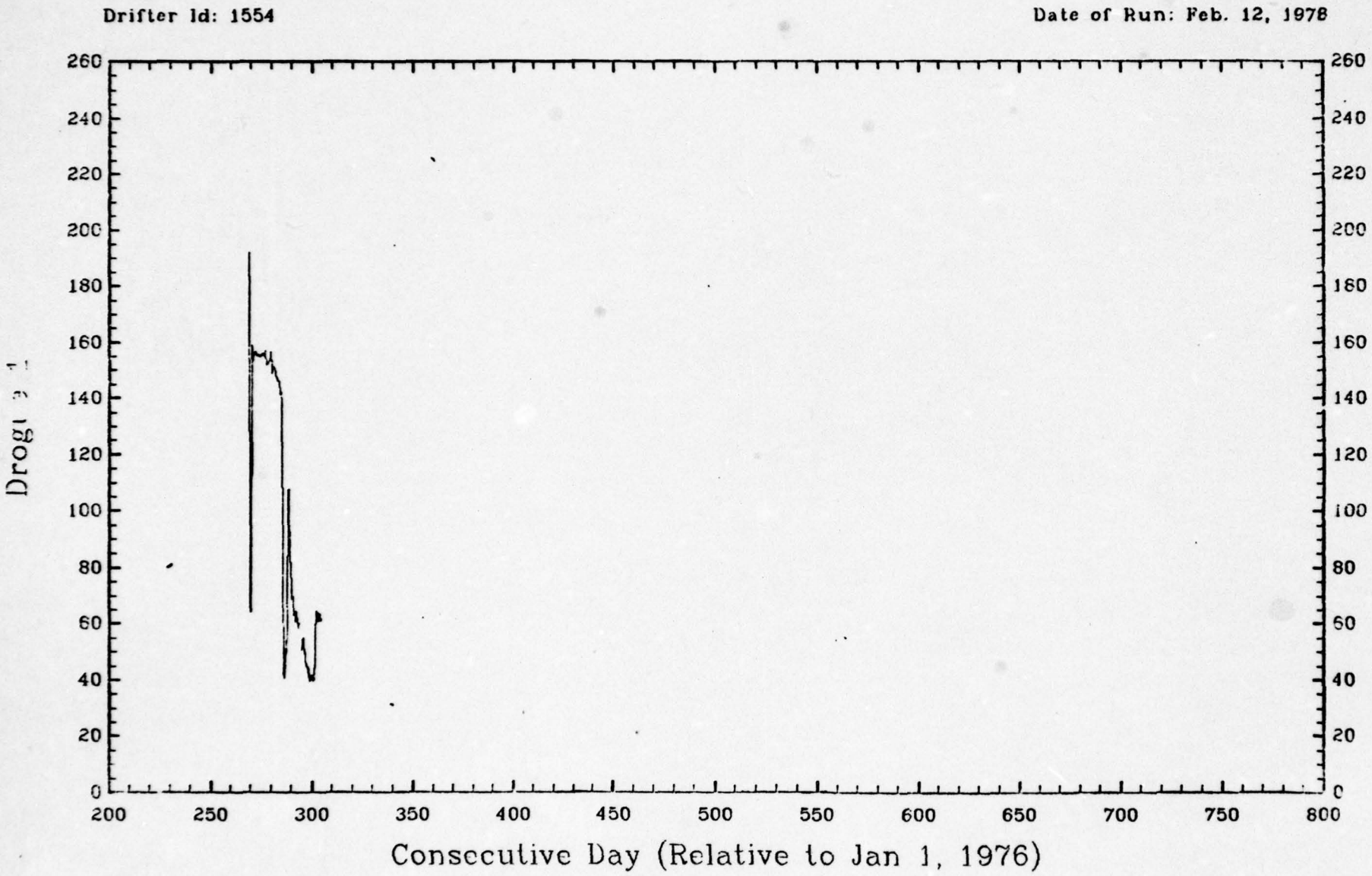
Period Covered:
June 1, 1976 to Sept. 15, 1977

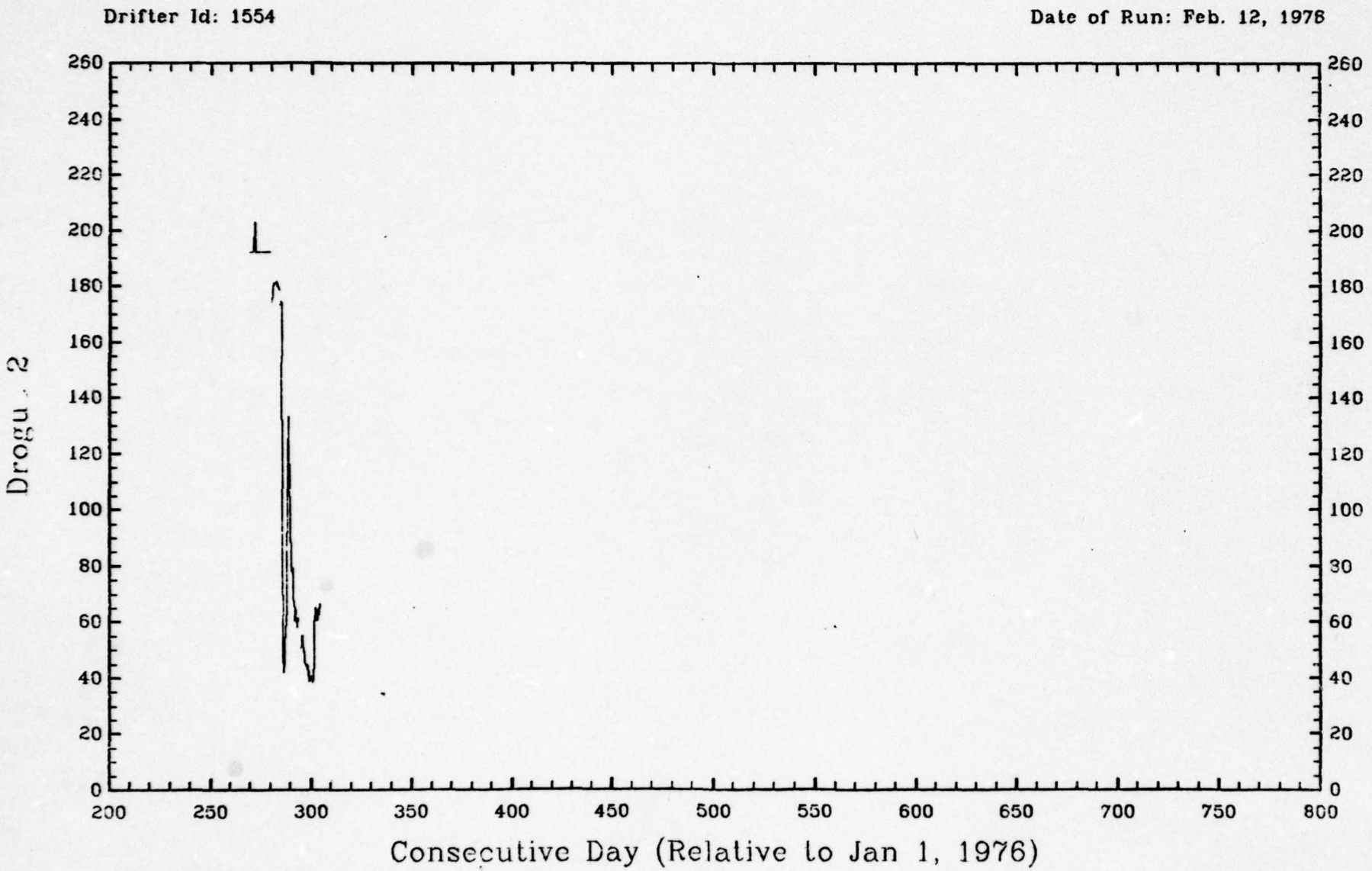


Symbol	Drifter Id
A	1554

Drifter Trajectories
Velocity Checked Positions

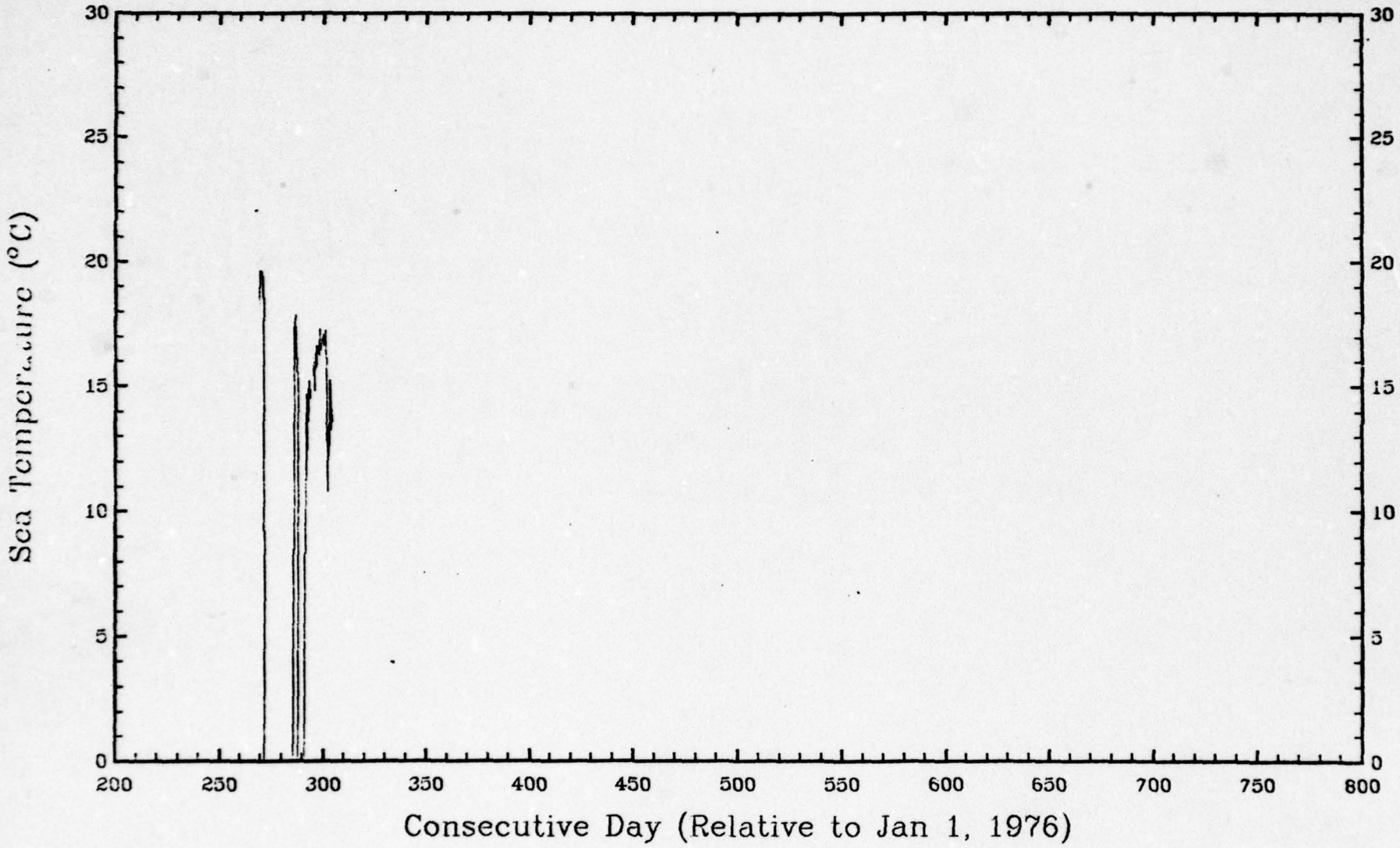

Drifter Id: 1554
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1554
Date of Run: Feb. 12, 1978
Drogue
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1554
Date of Run: Feb. 12, 1976
Drogue 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1554

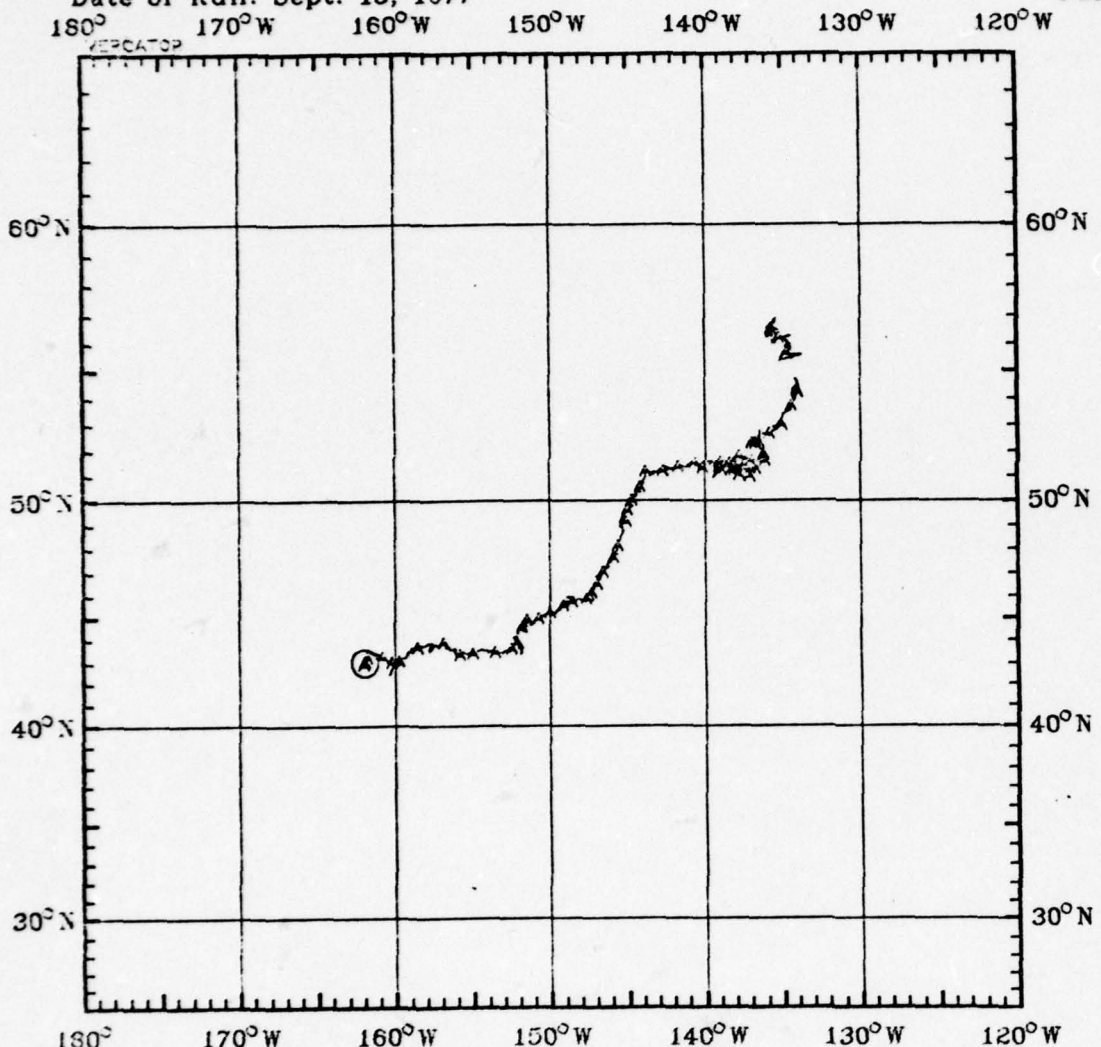
Date of Run: Feb. 12, 1978



Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

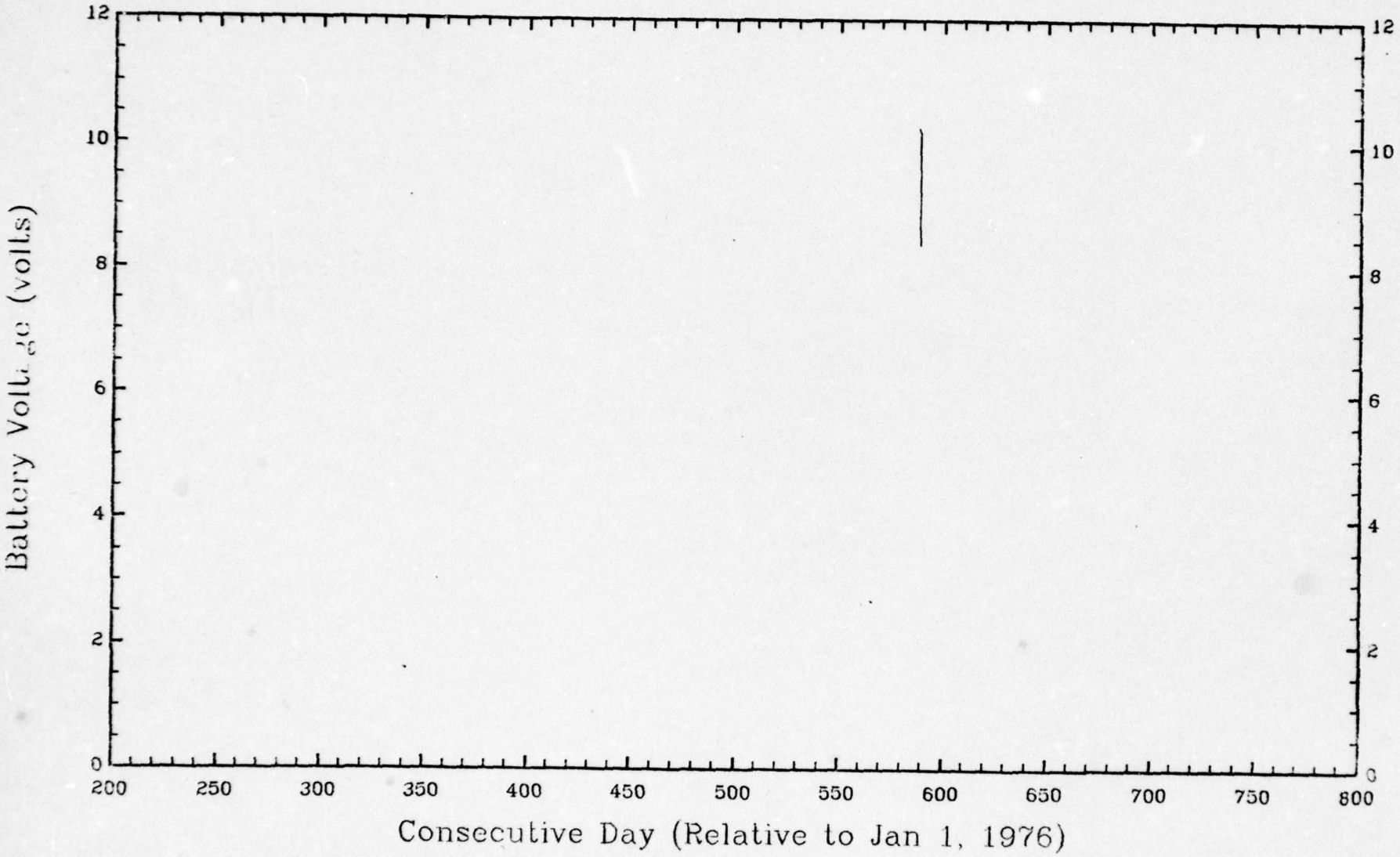
Symbol	Drifter Id
A	1562

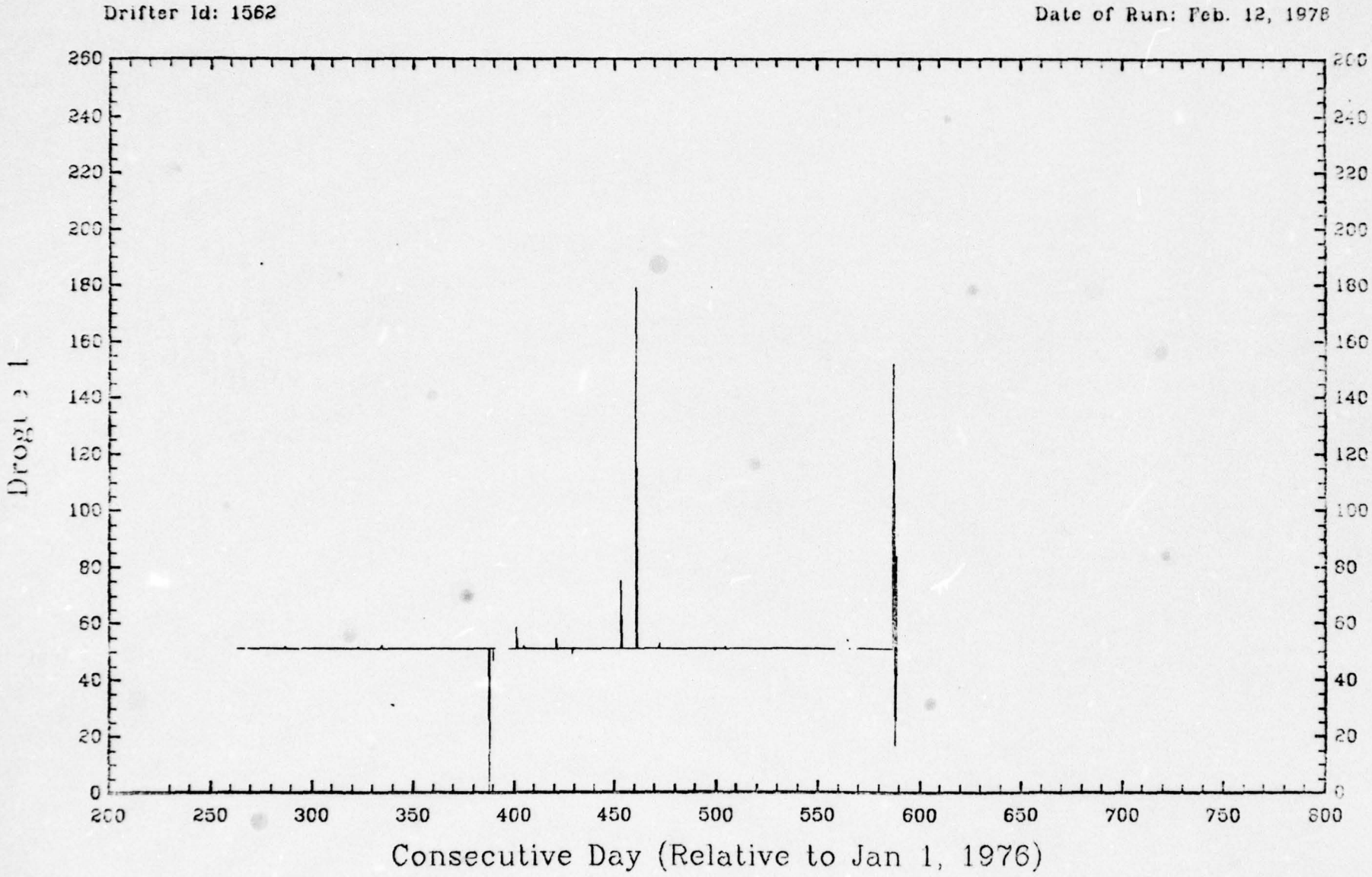


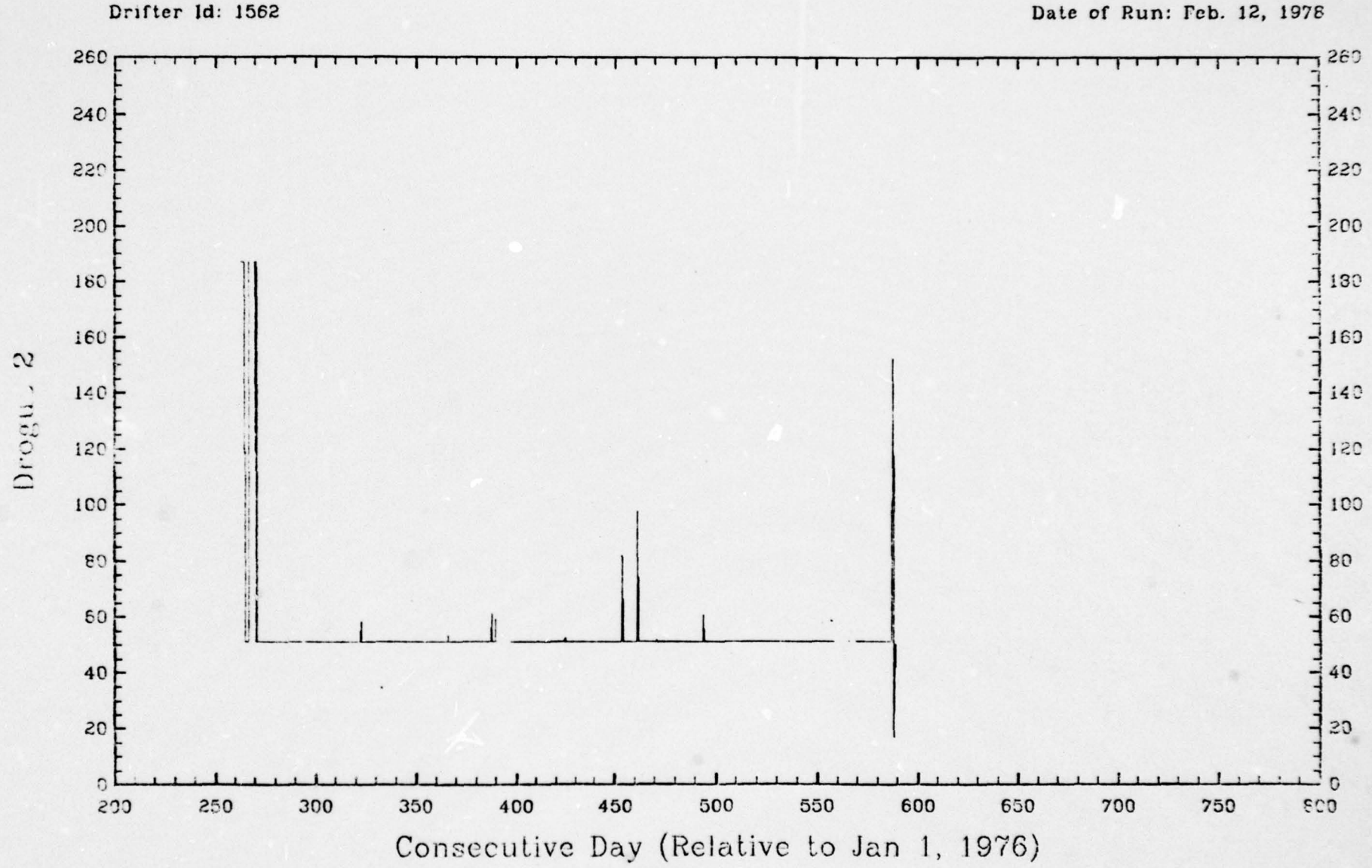
Drifter Trajectories
Velocity Checked Positions

Drifter Id: 1562

Date of Run: Feb. 6, 1978

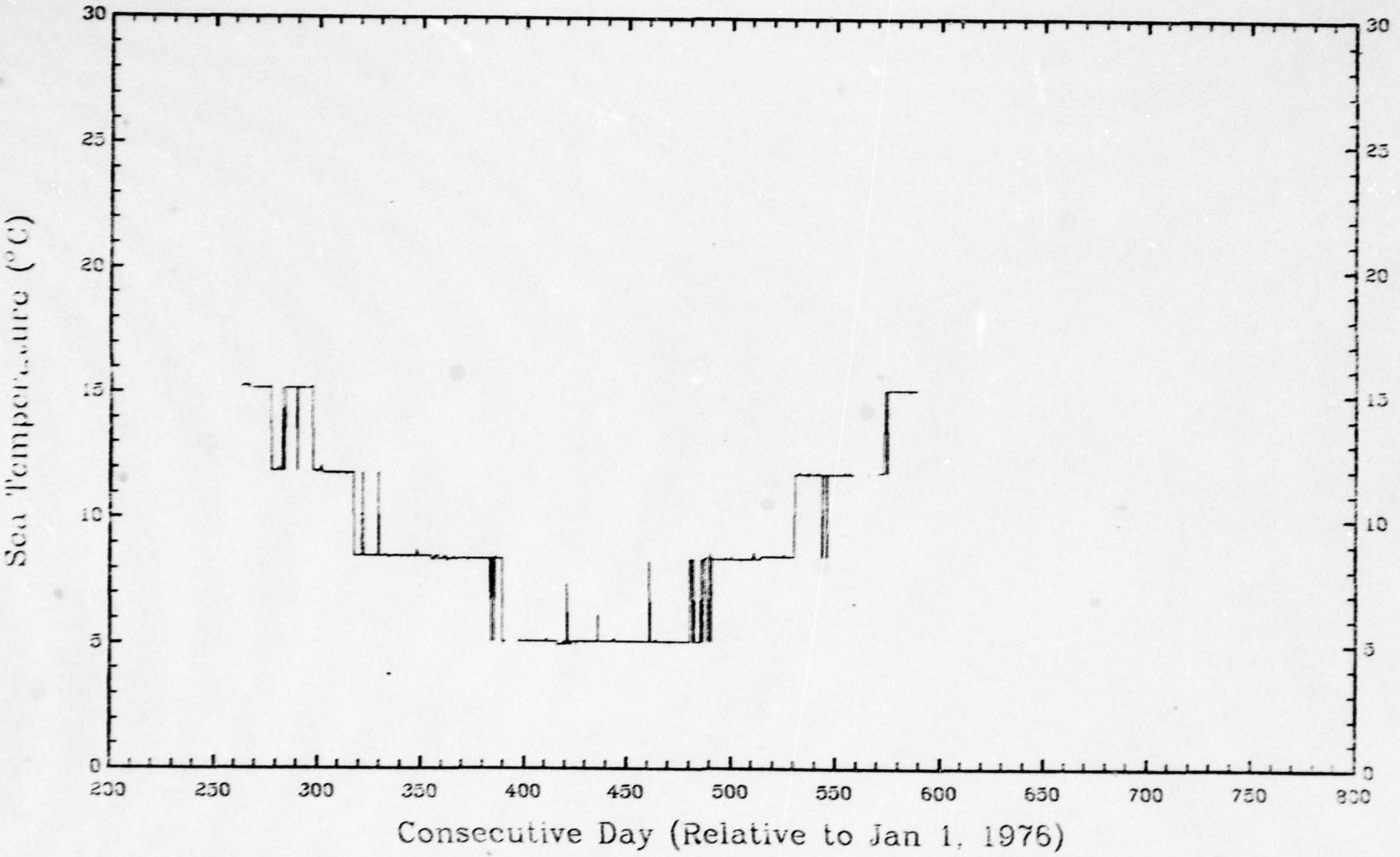



Drifter Id: 1562
Date of Run: Feb. 12, 1976
Drogue 1
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)


Drifter Id: 1562
Date of Run: Feb. 12, 1976
Drogue - 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

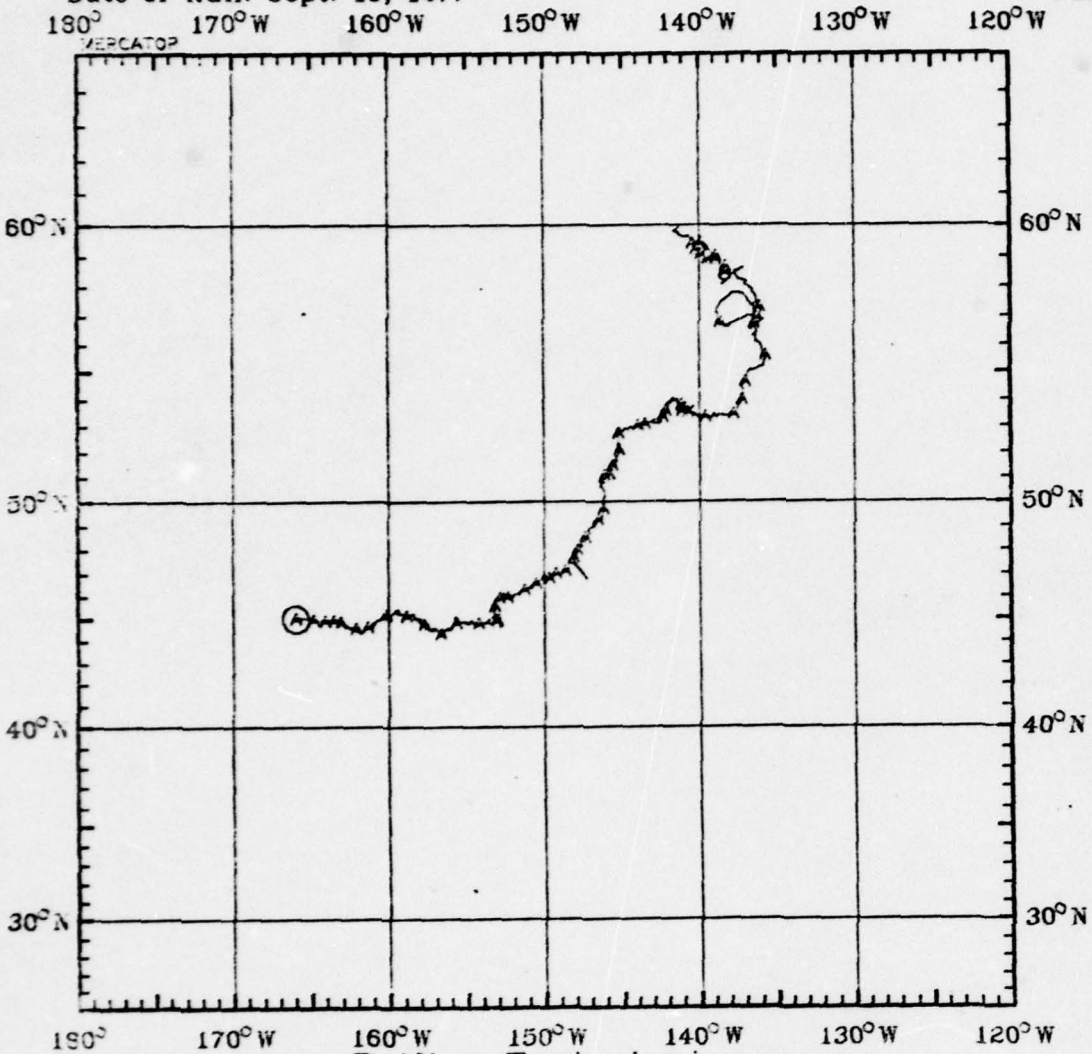
Drifter Id: 1562

Date of Run: Feb. 12, 1978



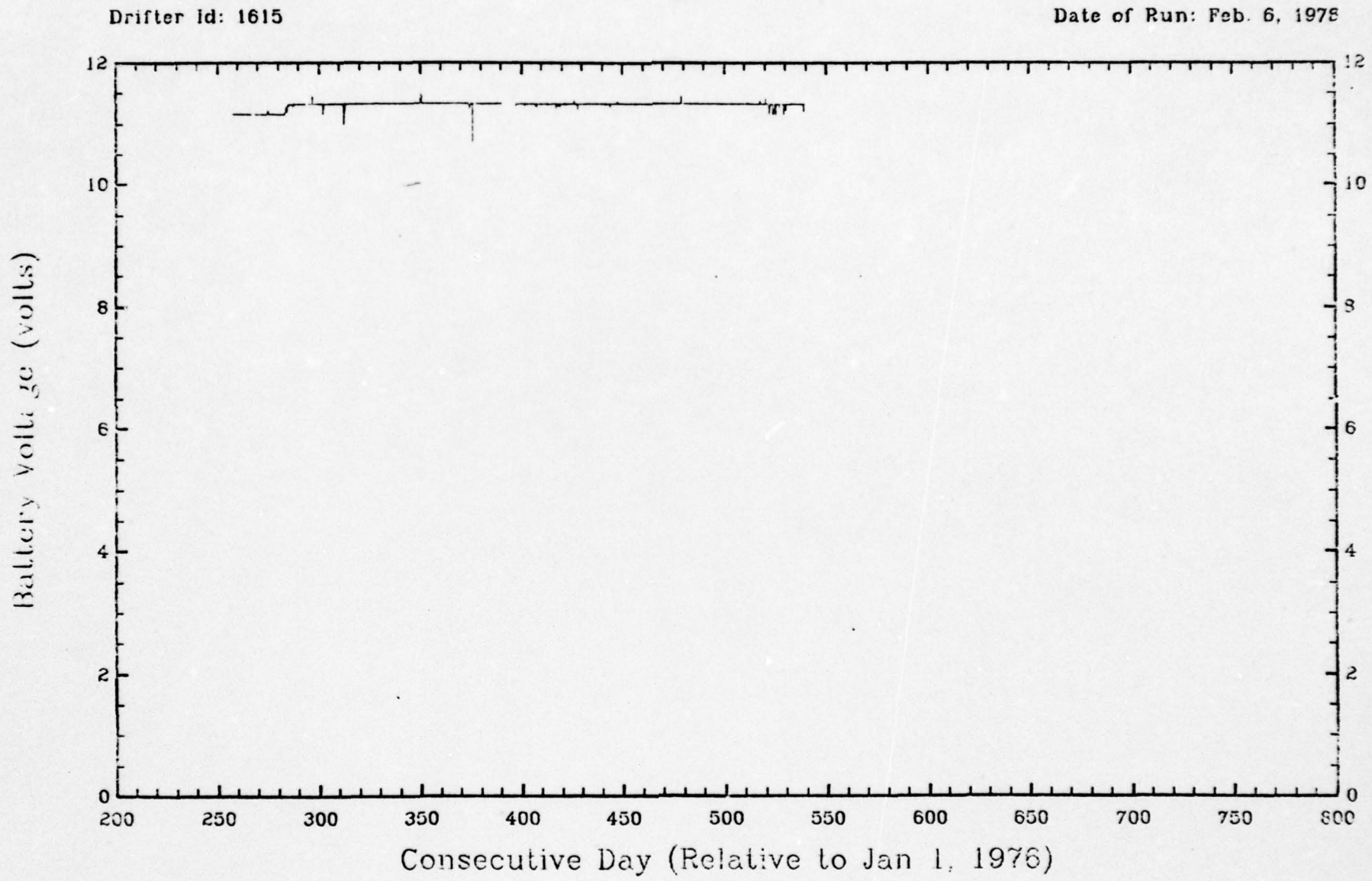
Date of Run: Sept. 15, 1977

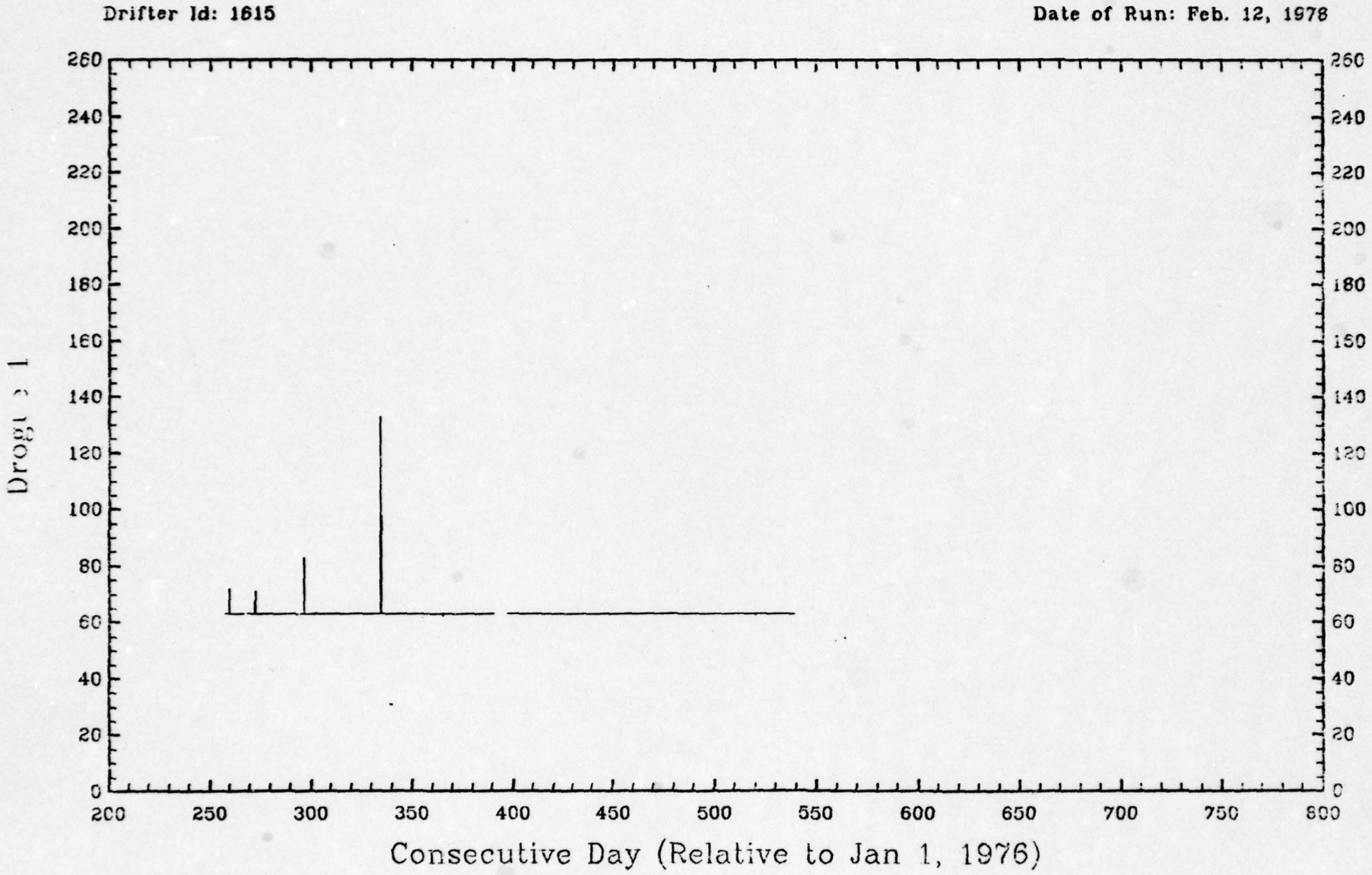
Period Covered:
June 1, 1976 to Sept. 15, 1977



Symbol	Drifter Id
A	1615

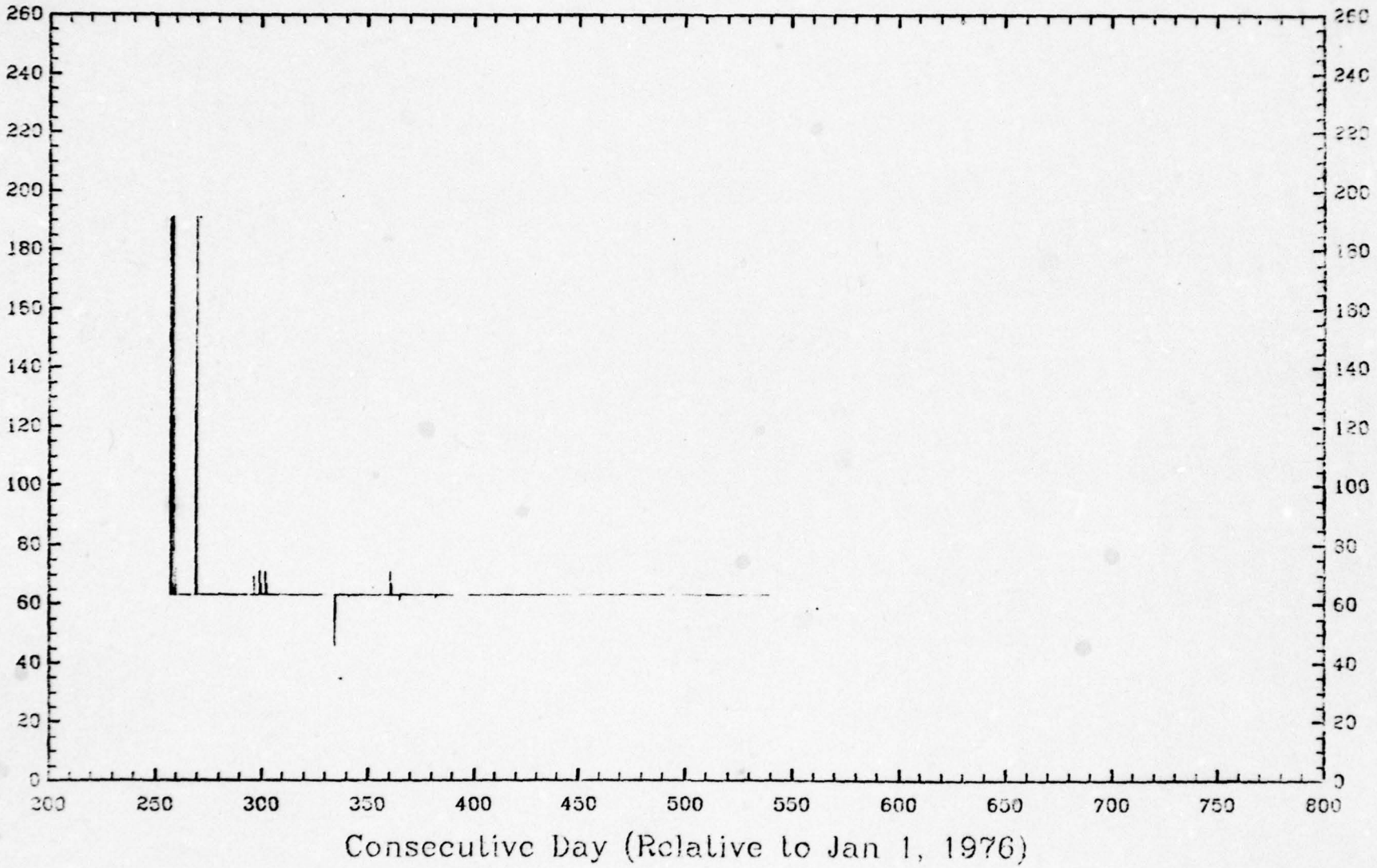
Drifter Trajectories
Velocity Checked Positions


Drifter Id: 1615
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

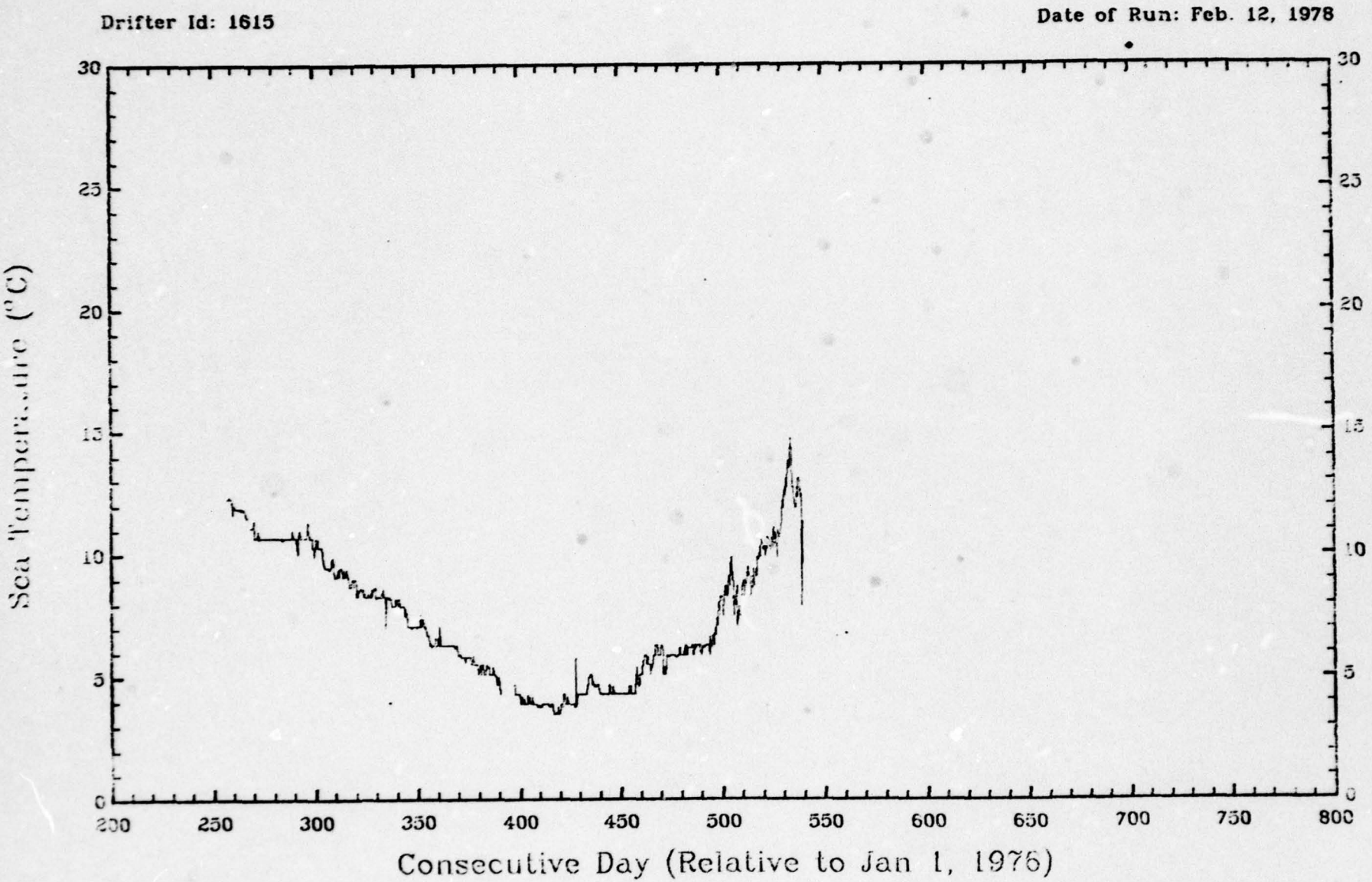

Drifter Id: 1615
Date of Run: Feb. 12, 1978
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1615

Date of Run: Feb. 12, 1978



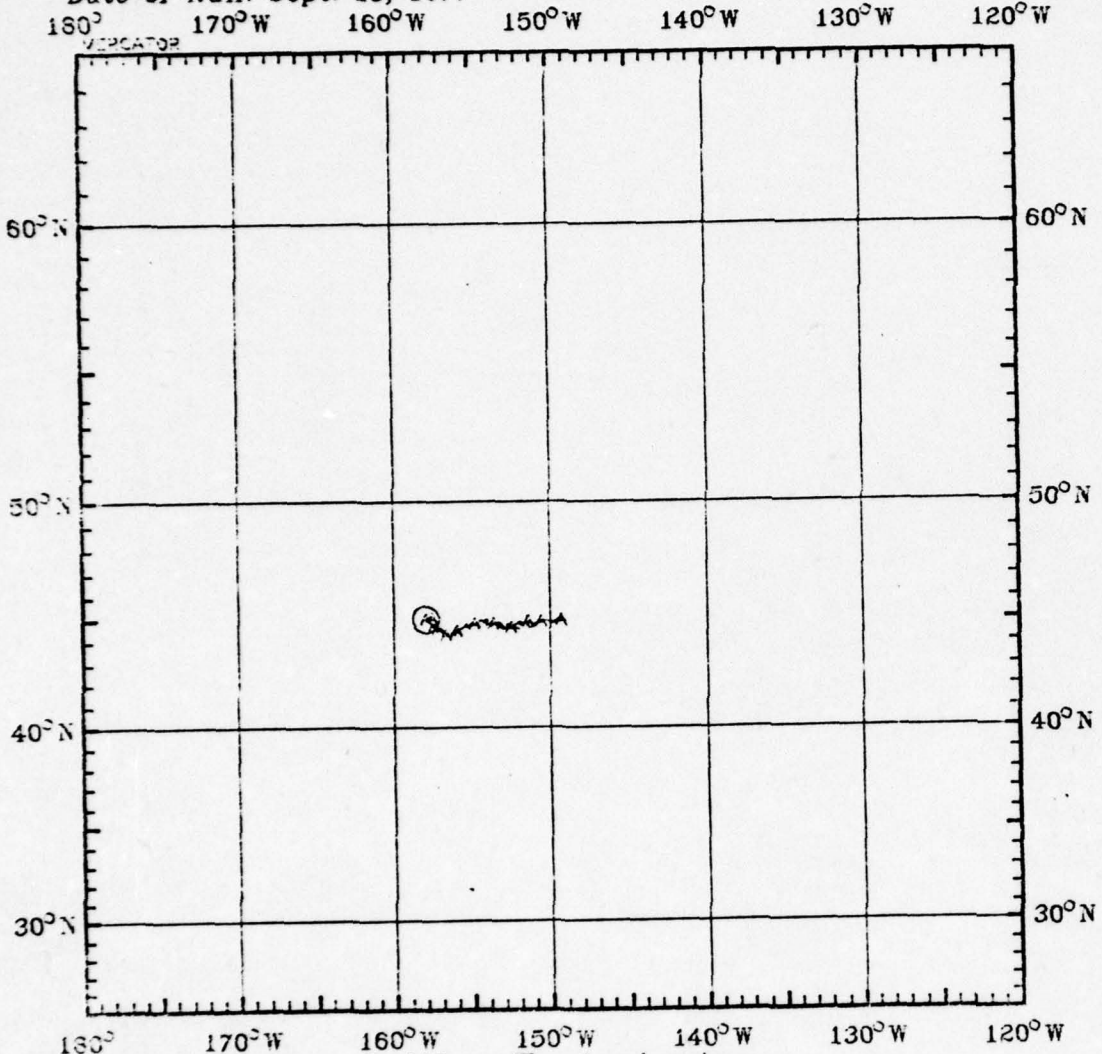
Drogue - 2


Drifter Id: 1615
Date of Run: Feb. 12, 1978
Sea Temperature (°C)
0
5
10
15
20
25
30
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

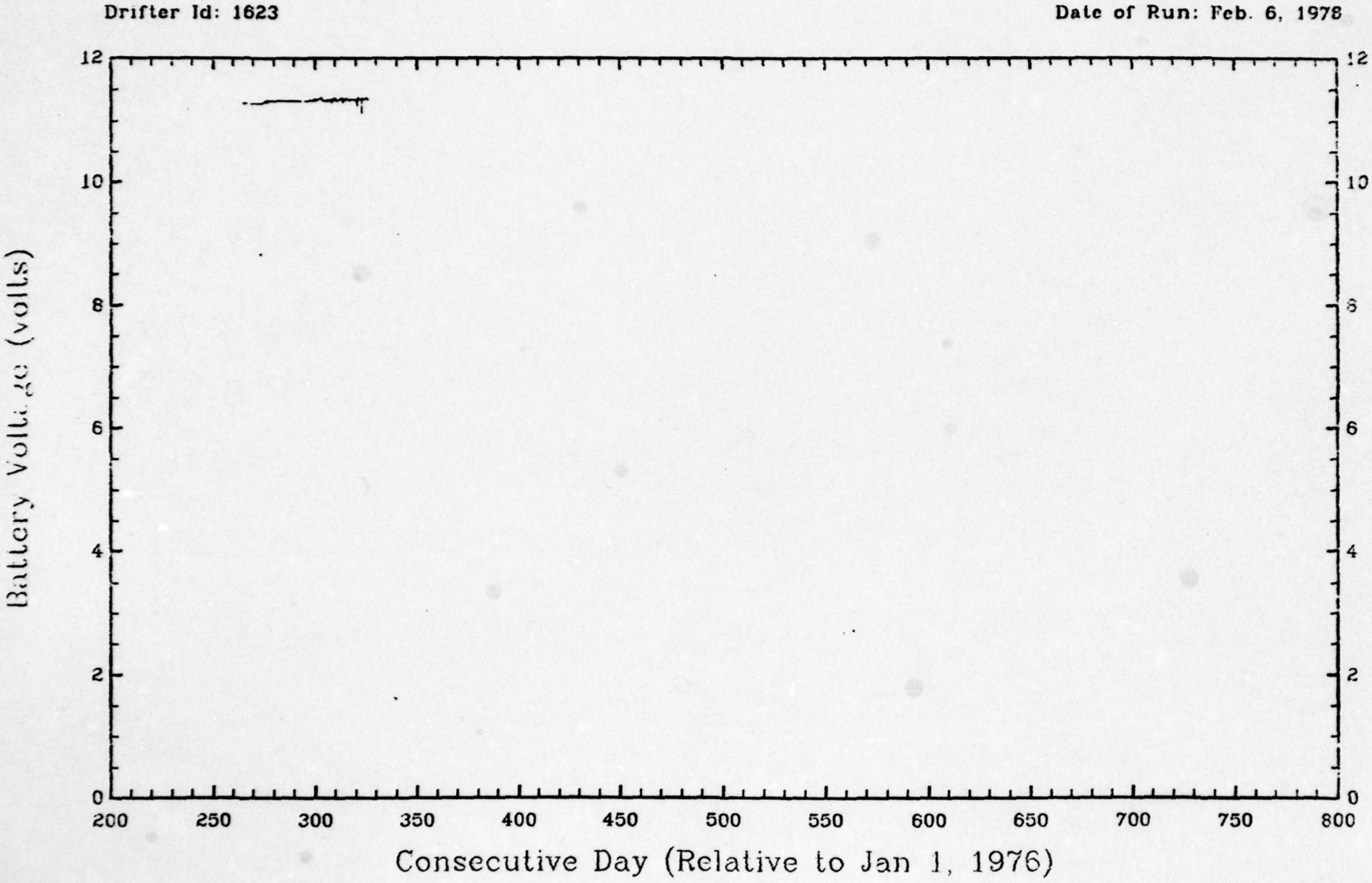
Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

Symbol	Drifter Id
A	1623

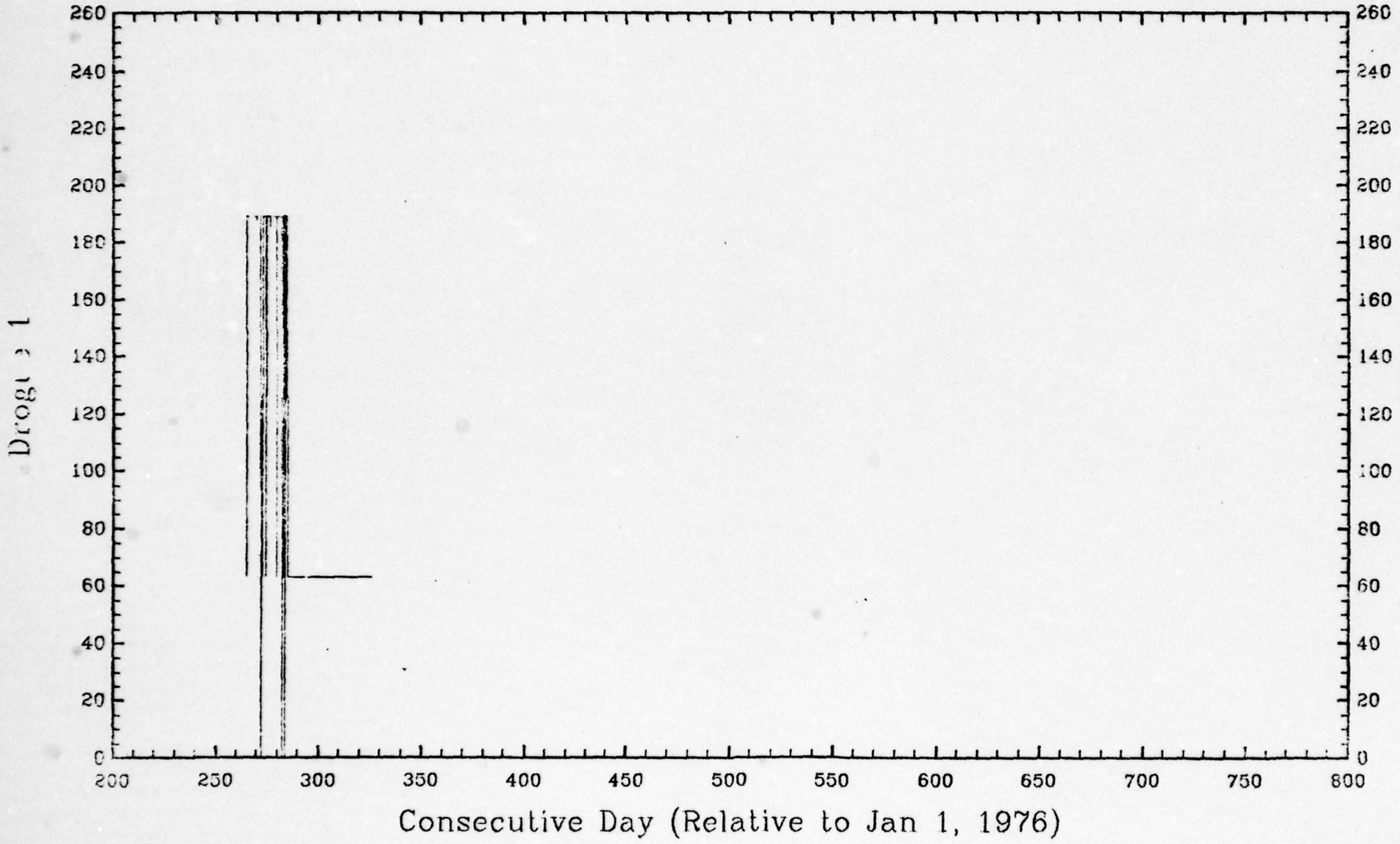


Drifter Trajectories
Velocity Checked Positions


Drifter Id: 1623
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

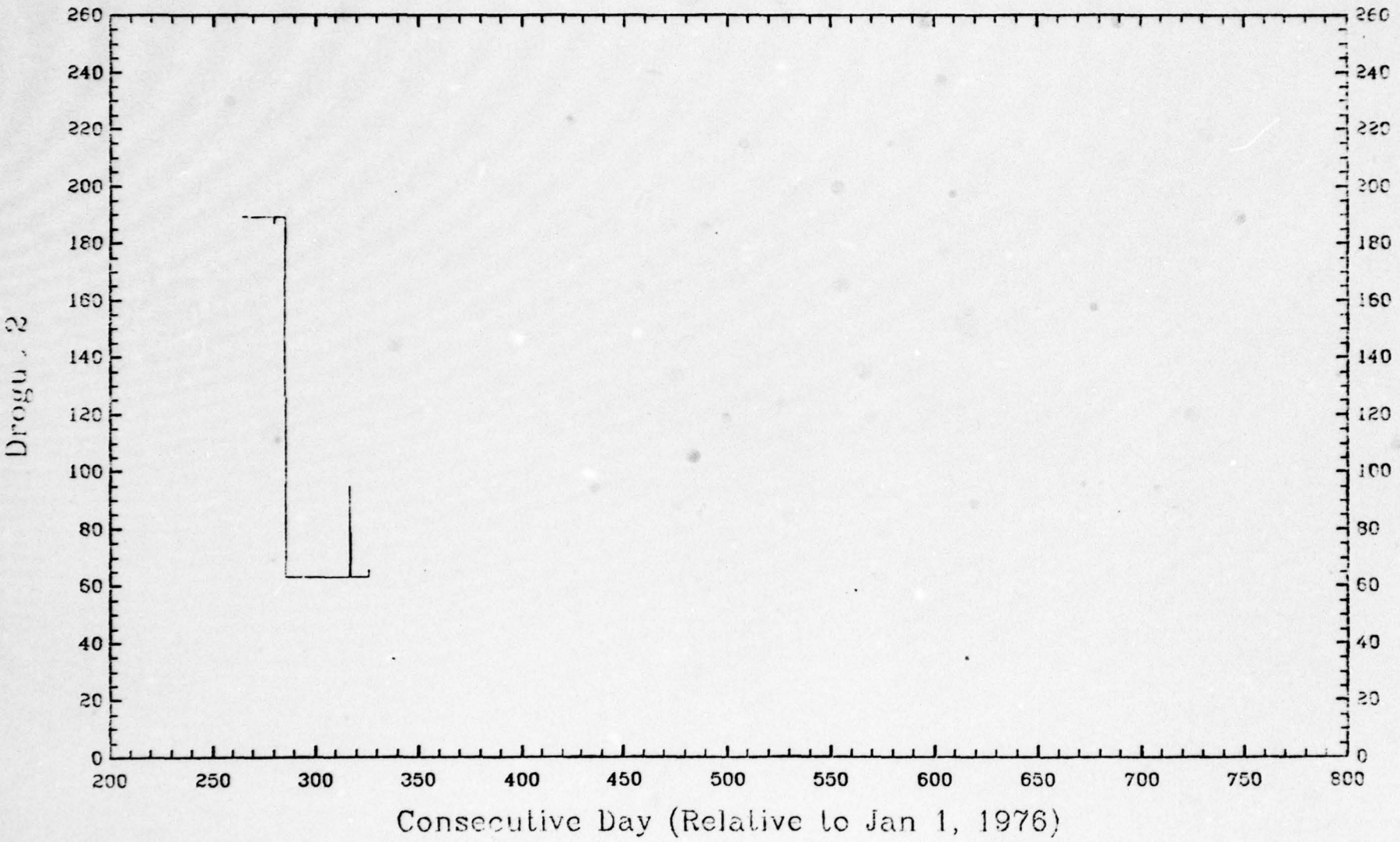
Drifter Id: 1623

Date of Run: Feb. 12, 1976



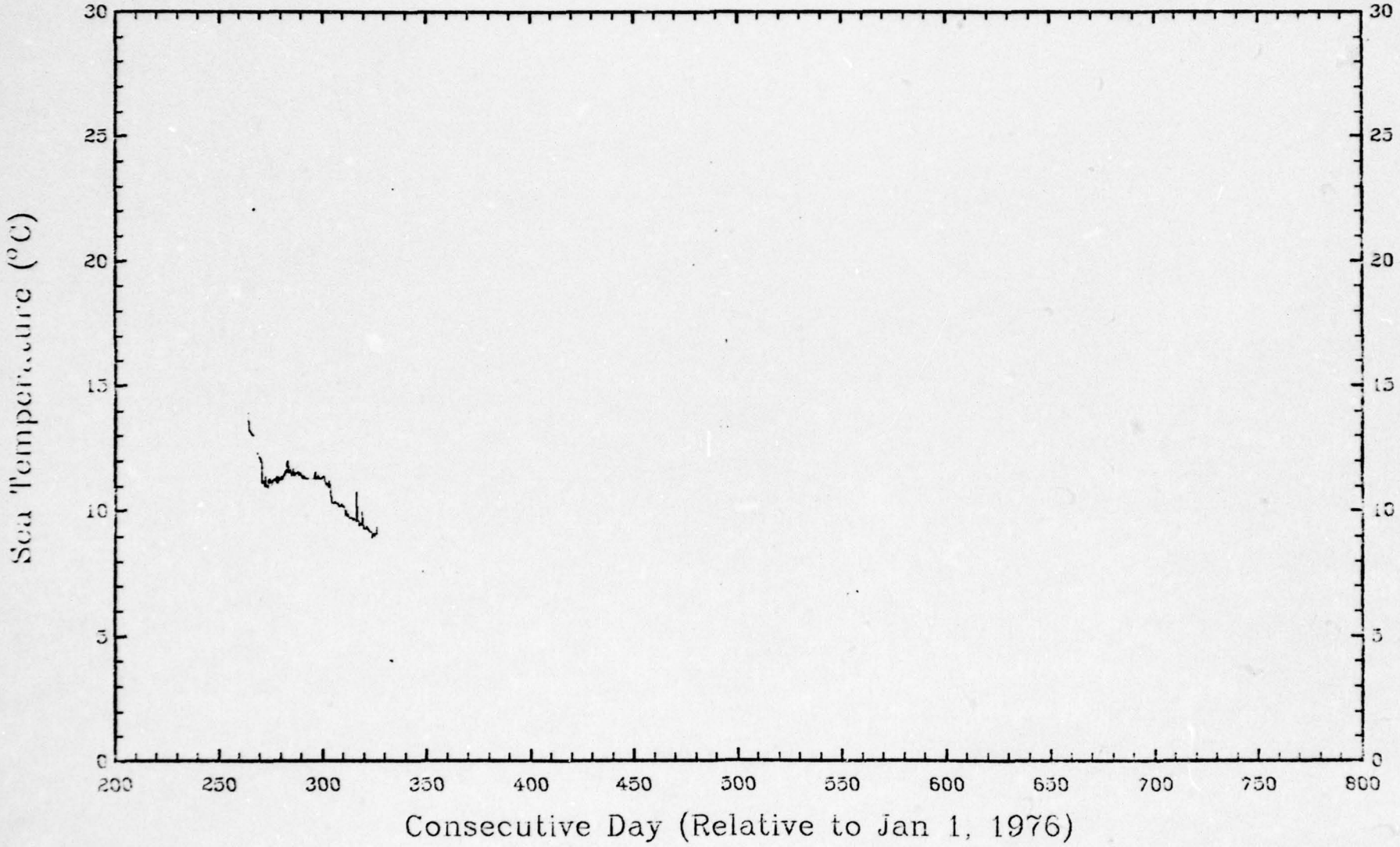
Drifter Id: 1623

Date of Run: Feb. 12, 1976



Drifter Id: 1623

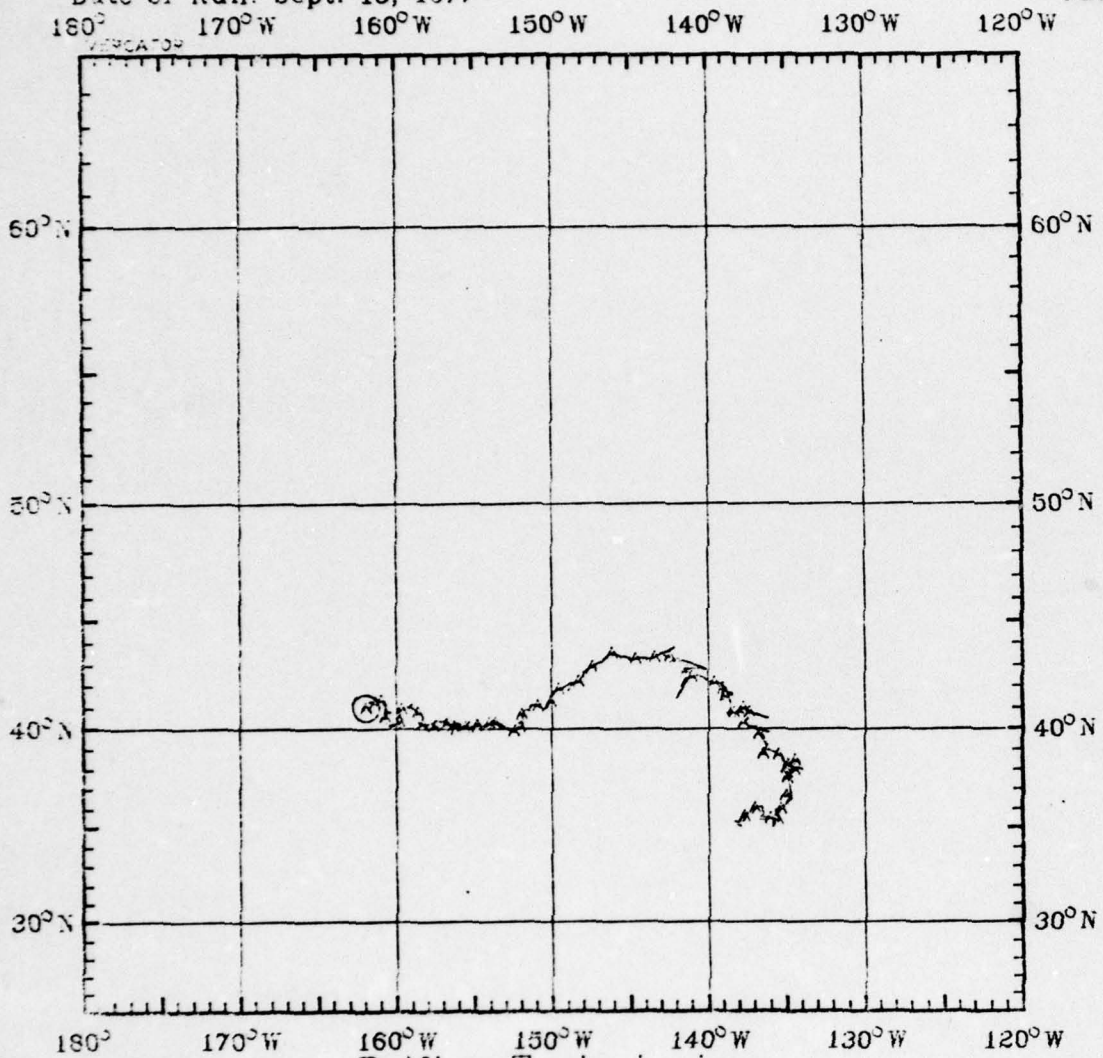
Date of Run: Feb. 12, 1978



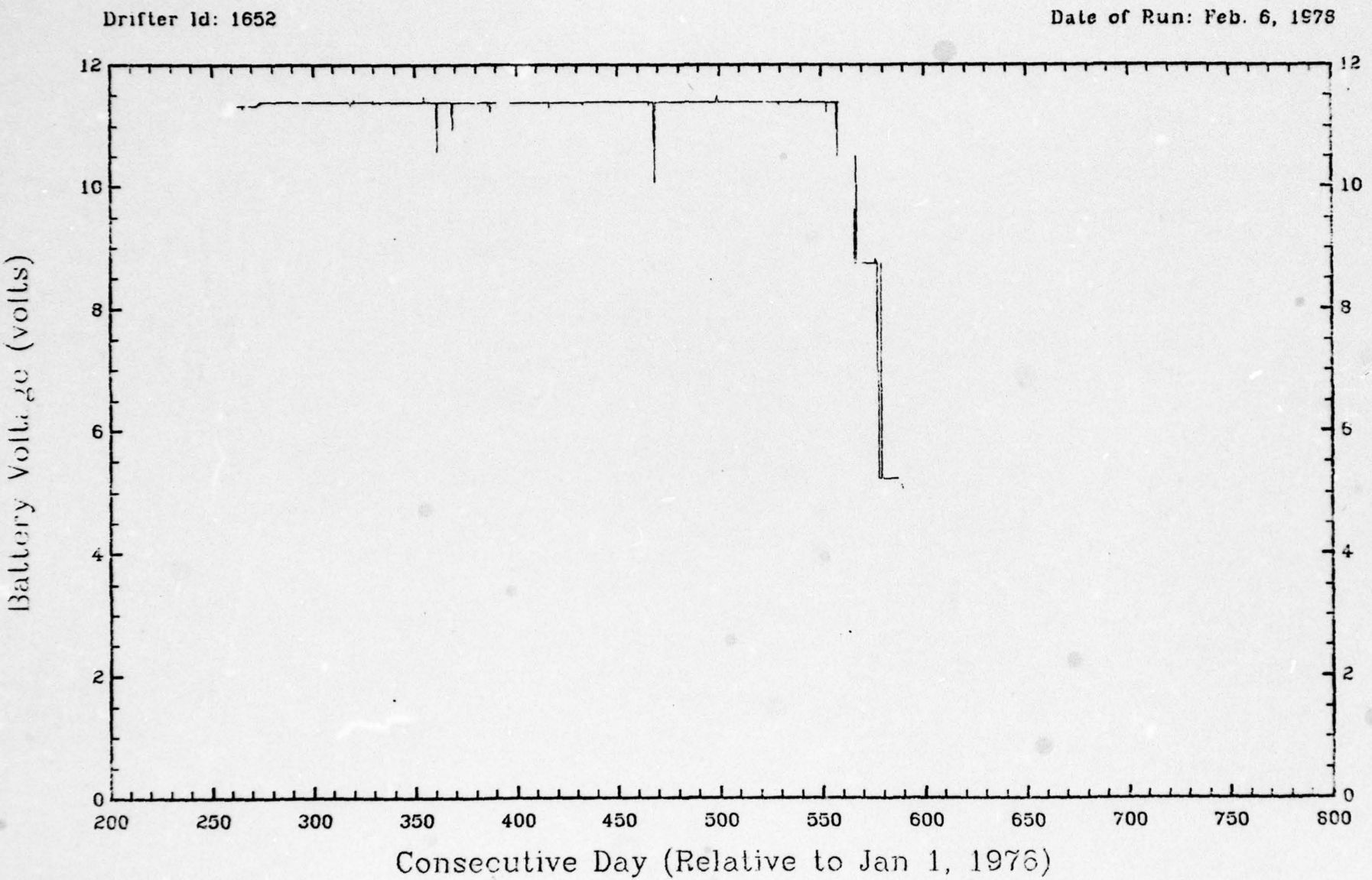
Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977

Symbol	Drifter Id
A	1652

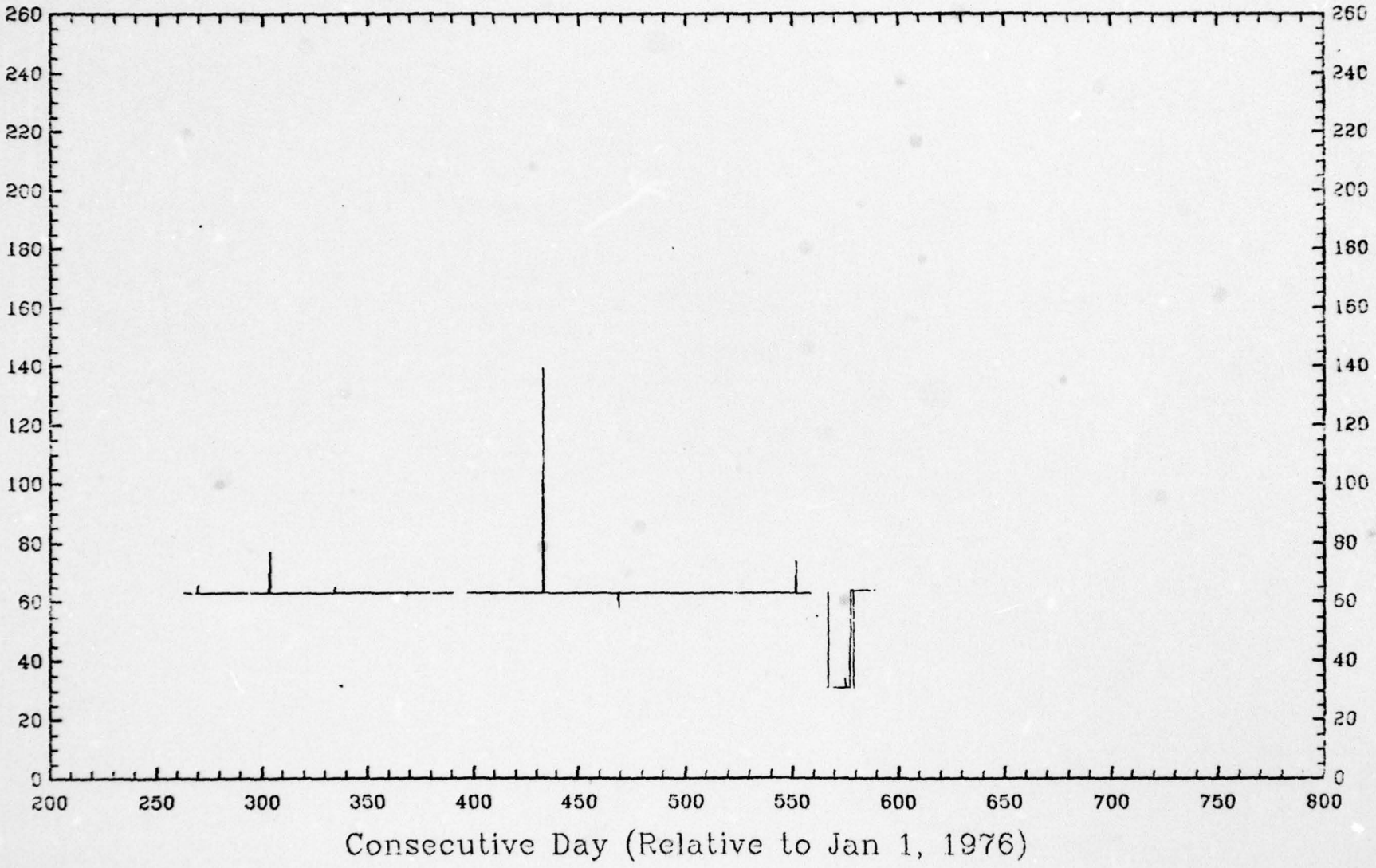


Drifter Trajectories
Velocity Checked Positions


Drifter Id: 1652
Date of Run: Feb. 6, 1978
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

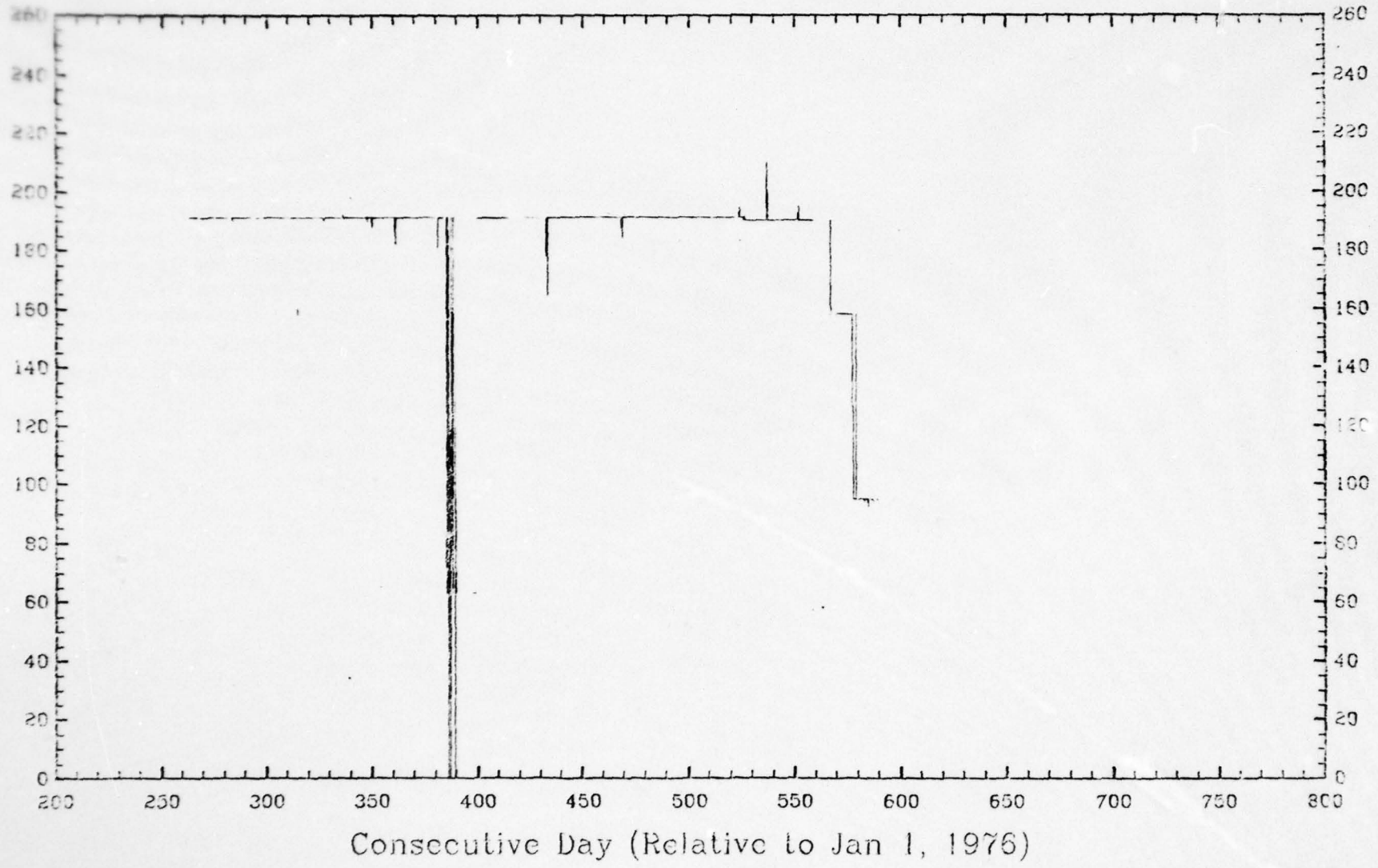
Drifter Id: 1652

Date of Run: Feb. 12, 1976



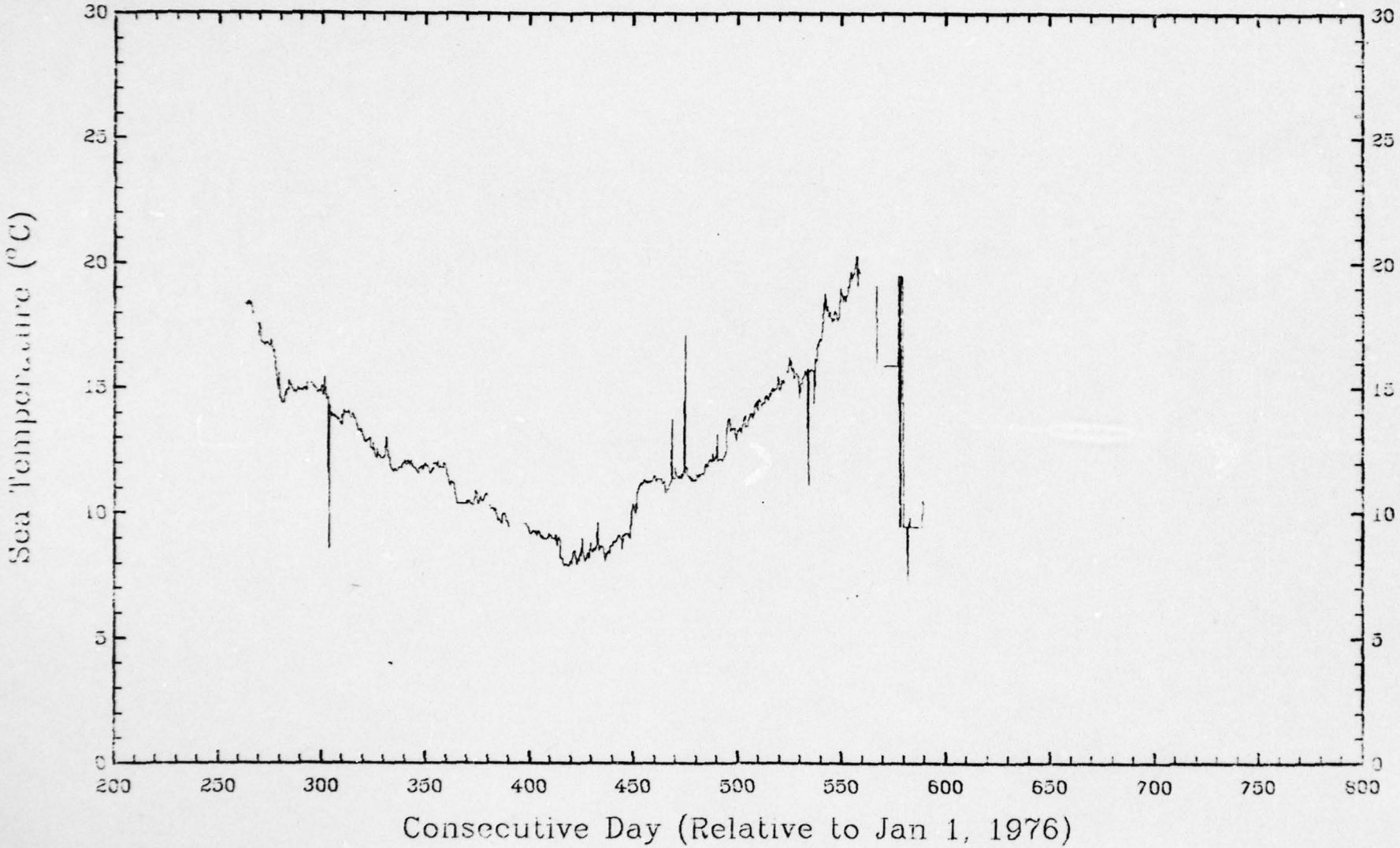
Drifter Id: 1652

Date of Run: Feb. 12, 1978



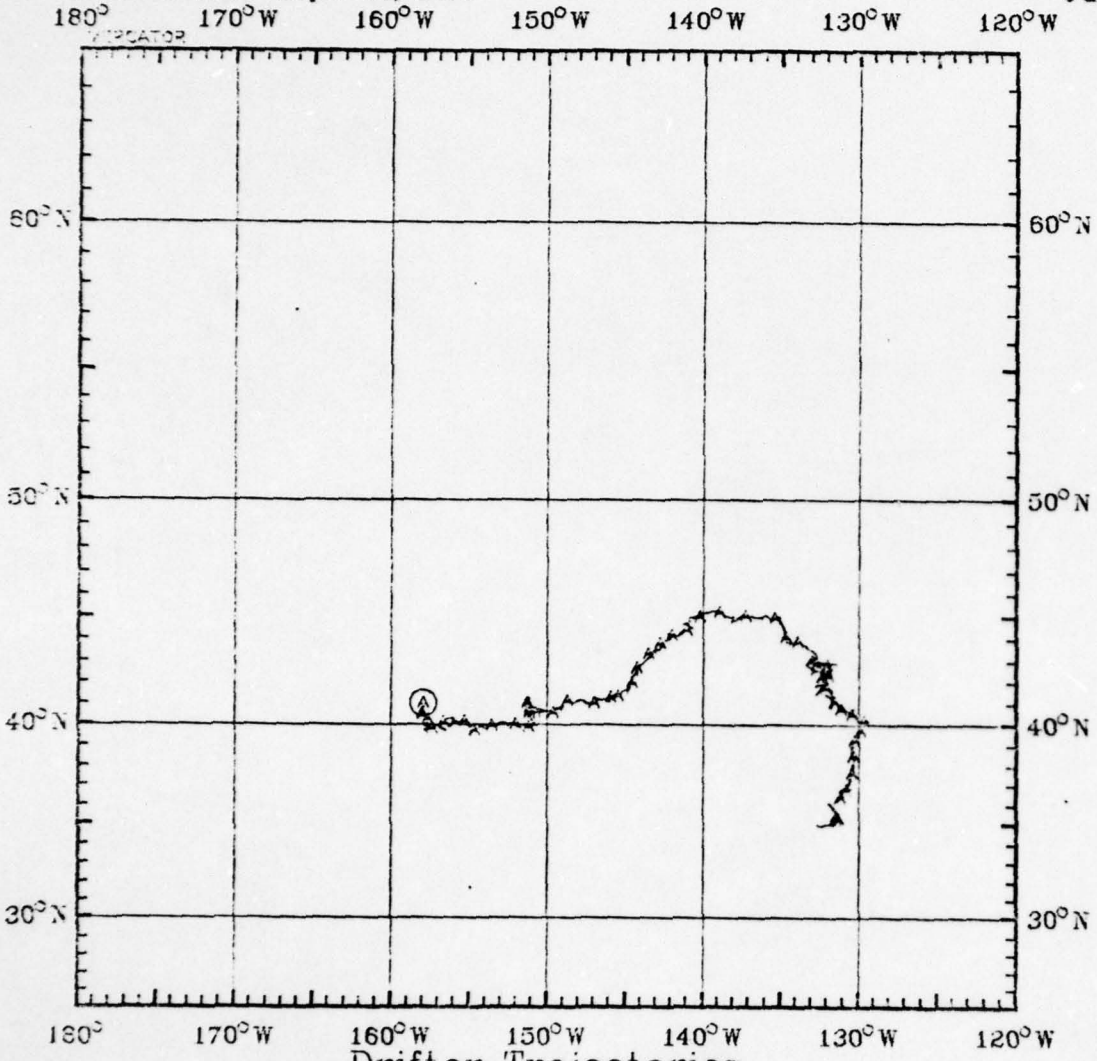
Drifter Id: 1652

Date of Run: Feb. 12, 1978



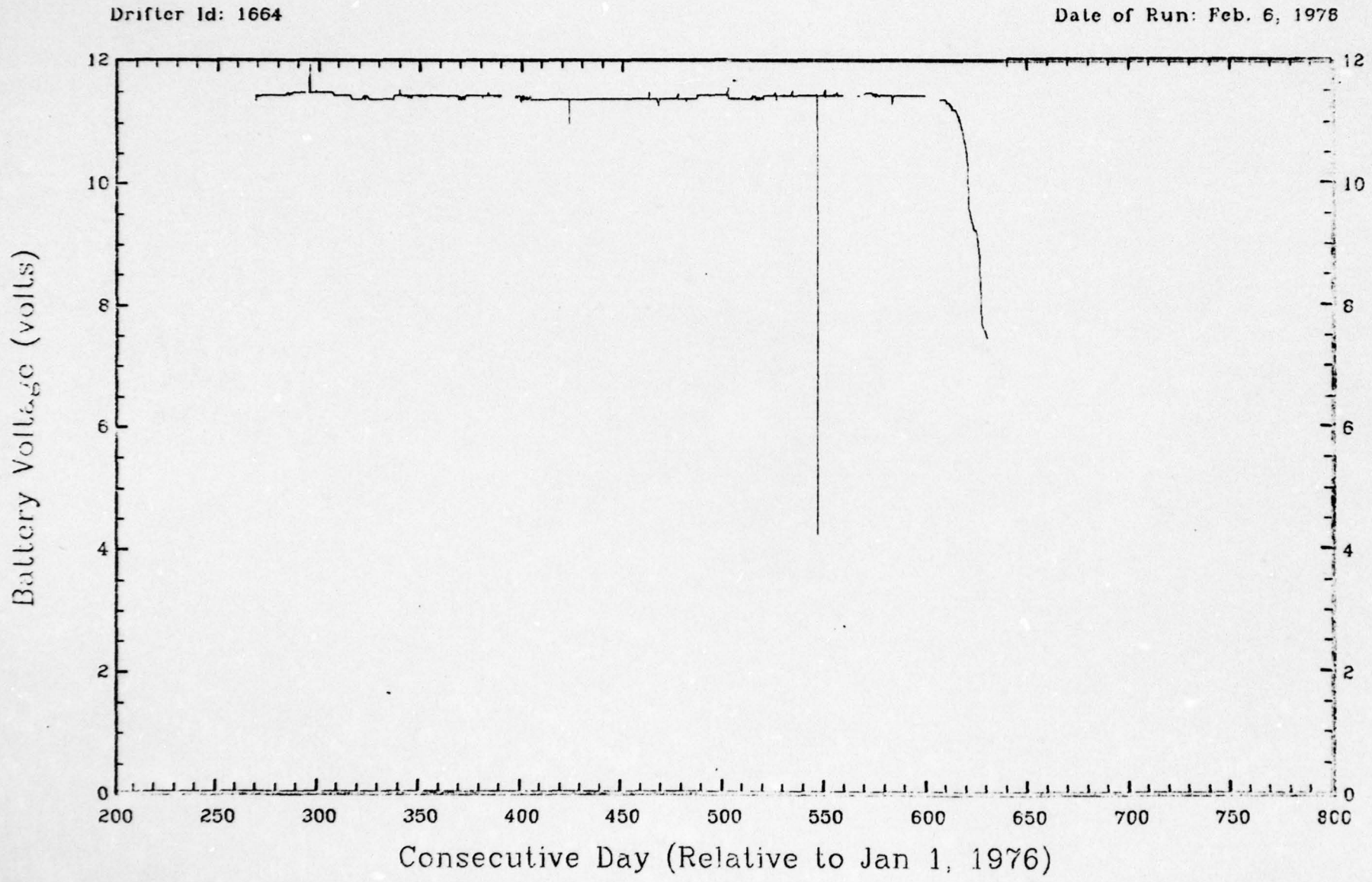
Date of Run: Sept. 15, 1977

Period Covered:
June 1, 1976 to Sept. 15, 1977



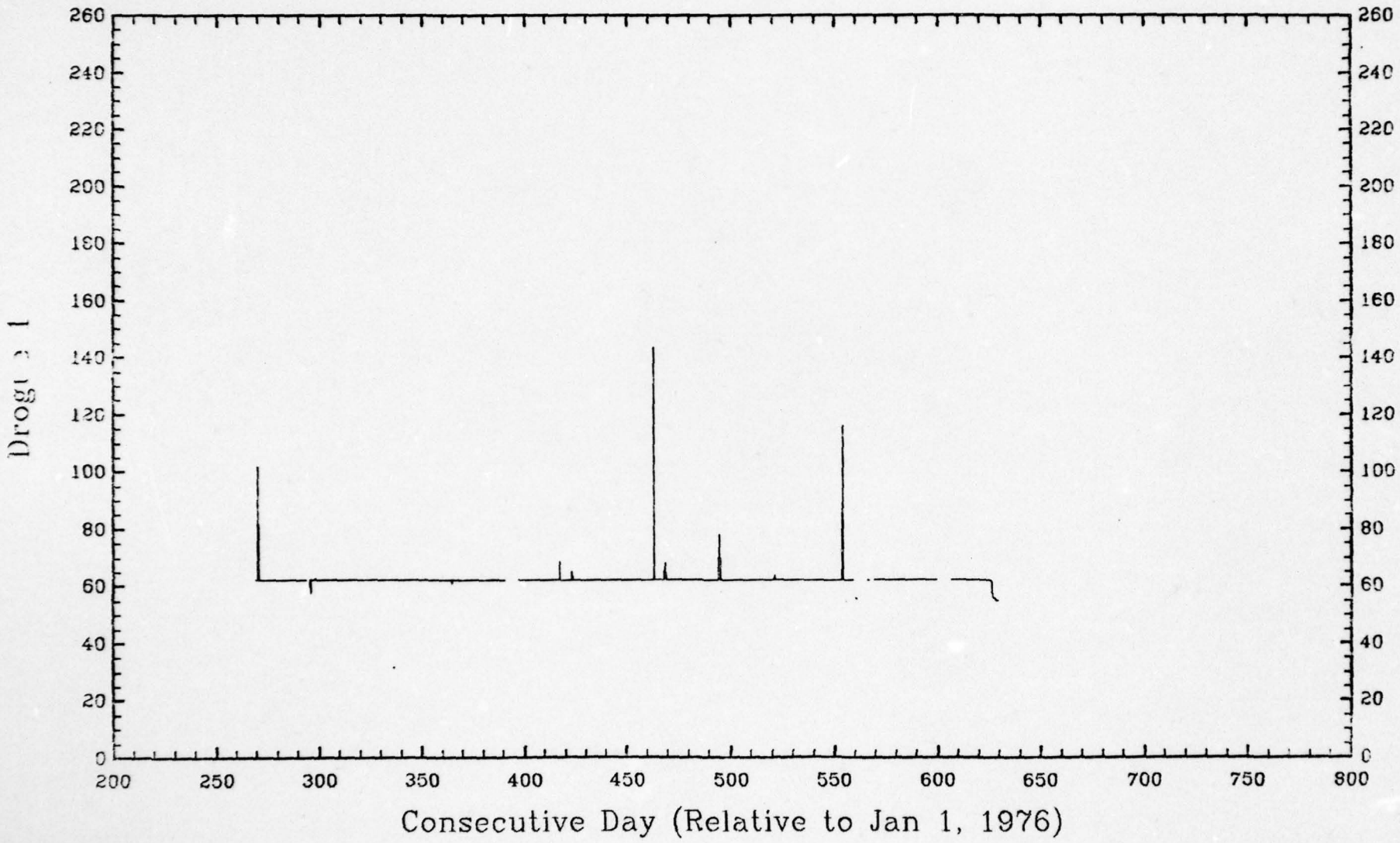
Symbol	Drifter Id
A	1664

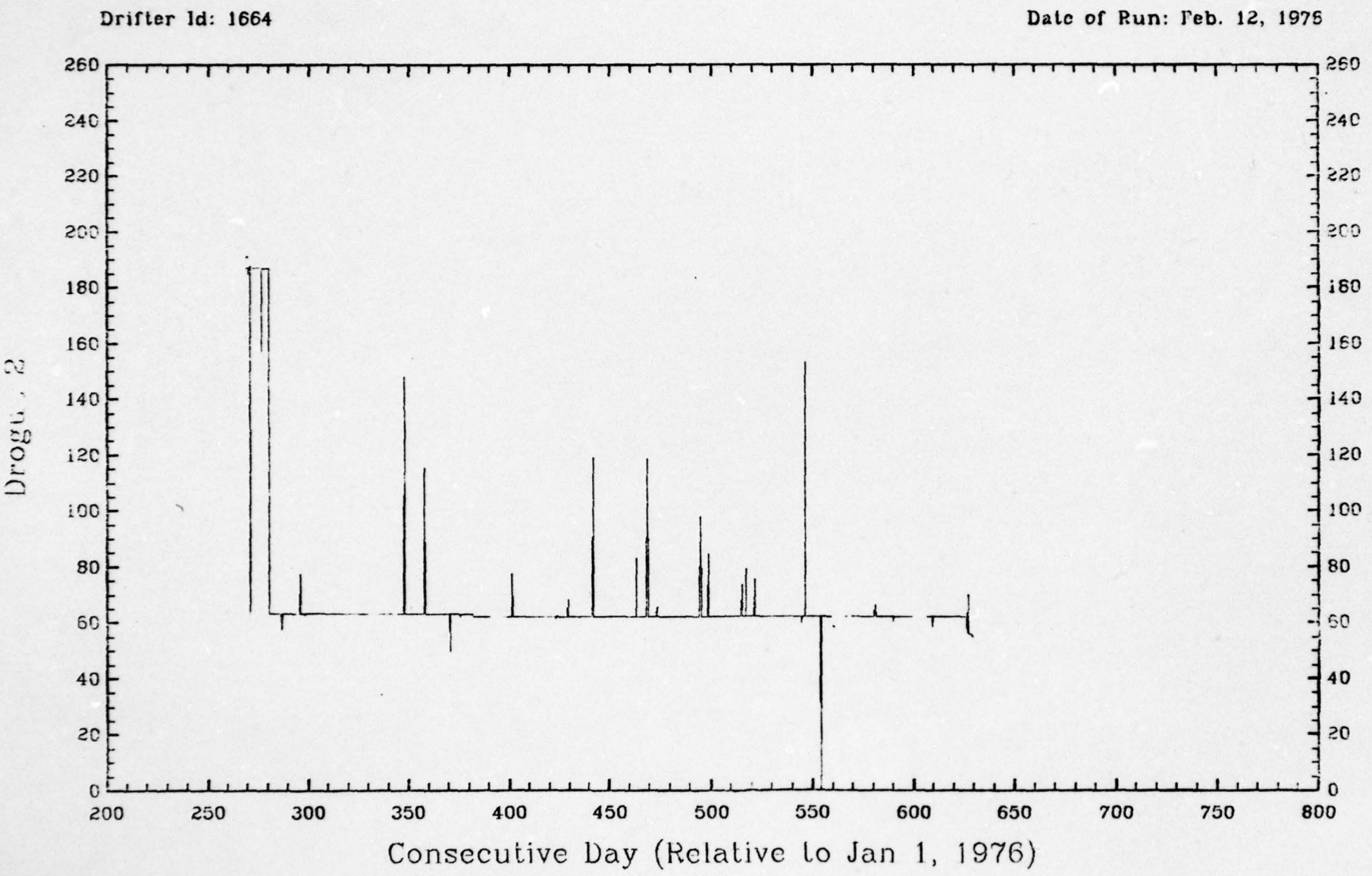
Drifter Trajectories
Velocity Checked Positions


Drifter Id: 1664
Date of Run: Feb. 6, 1976
Battery Voltage (volts)
0
2
4
6
8
10
12
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1664

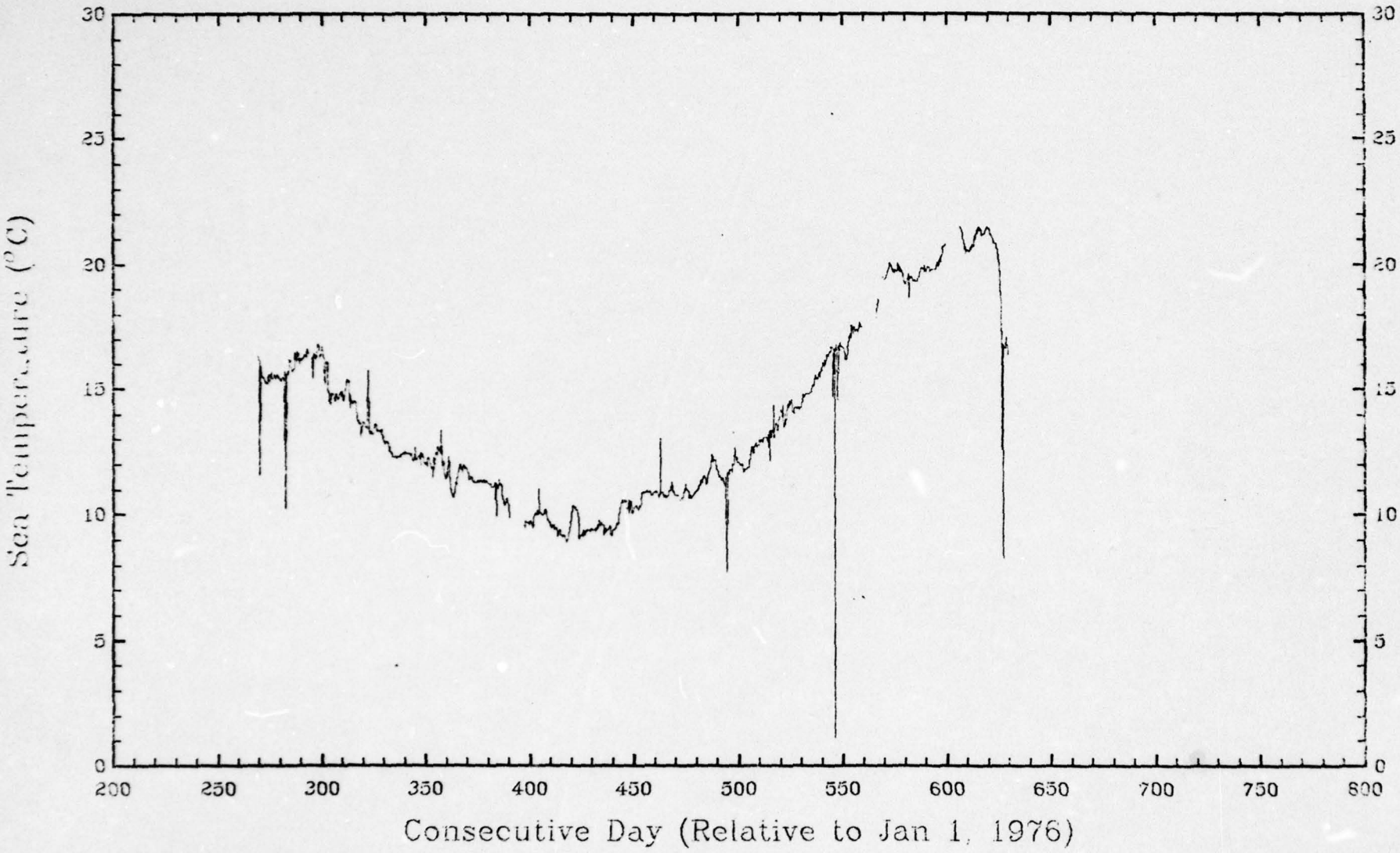
Date of Run: Feb. 12, 1978




Drifter Id: 1664
Date of Run: Feb. 12, 1976
Drogue, 2
260
240
220
200
180
160
140
120
100
80
60
40
20
0
200
250
300
350
400
450
500
550
600
650
700
750
800
Consecutive Day (Relative to Jan 1, 1976)

Drifter Id: 1664

Date of Run: Feb. 12, 1978



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